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TUBERCULOSIS OF SWINE IN THE PHILIPPINE ISLANDS [1]

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THREE PLATES

In his historical account of tuberculosis in the Philippine Islands presented before the First National Anti-Tuberculosis Congress in 1926 Calderon(1) stated that the disease was as old as the history of the Filipino people. Prior to 1902, when the American administration established the first Board of Health, no records were available of any organized effort to control or eradicate tuberculosis during the Spanish régime. Even this newly created Board of Health did not provide definite plans to combat the disease, because its major activities embraced health problems of a more general nature. It was only in 1908 that the City Council of Manila passed an ordinance prohibiting spitting in public places, vehicles, etc. If this was the situation with regard to human tuberculosis, it would seem reasonable to believe that the occurrence of the disease in swine was not even suspected. Indeed, among many early chronicles there was nothing to indicate that any organized system of examining meat animals for human consumption was promulgated by law. Consequently, no published work dealing with tuberculosis in local swine is available.

[1] Bureau of Animal Industry Technical Bulletin 3. From the veterinary division, Bureau of Animal Industry, Manila. Received for publication April 4, 1933.

INCIDENCE

The establishment of a meat-inspection service at the Manila abattoir by the Bureau of Agriculture in 1907 brought to light the presence of what was thought to be tuberculosis in native swine. The entire carcass of any hog slaughtered at the abattoir was condemned as unfit for food when it showed apparent lesions of generalized tuberculosis, and parts were condemned when the lesions were local. In Table 1, it can be noted that during the year 1916 there were 157 whole carcasses and 507 parts condemned for tuberculosis from a total of 93,643 hogs slaughtered. The condition was the reverse in 1928, when of 122,717 slaughtered only 8 whole carcasses were condemned as against 13,538 parts. The fall in the number of whole carcasses condemned might be due, in a measure, to a more careful selection on the part of the wholesale hog dealers to meet the rigid meat-inspection regulations. From the standpoint of epizoölogy, the figures in the table do not represent the actual extent of the disease in the swine population of the country, as will be shown.

TABLE 1.—*Tuberculous carcasses and parts of hogs condemned at the Manila abattoir, 1907–1931.*

[Prepared by the animal statistics section, animal disease control division, Bureau of Animal Industry.]

Year.	Number slaughtered.	Tuberculous carcasses.	Tuberculous parts.	Year.	Number slaughtered.	Tuberculous carcasses.	Tuberculous parts.
1907	55,360	1	----------	1921	104,017	31	454
1908	58,119	----------	----------	1922	115,034	32	244
1909	60,789	----------	----------	1923	114,961	36	385
1910	63,043	----------	----------	1924	119,877	42	445
1911	65,593	8	----------	1925	118,763	29	253
1912	71,060	15	363	1926	116,731	21	269
1913	103,238	11	969	1927	117,063	14	4,707
1914	75,543	----------	326	[b] 1928	122,717	8	13,538
1915	84,736	10	175	1929	133,011	2	9,568
[a] 1916	93,643	157	507	1930	123,532	6	5,357
1917	107,626	76	1,370	1931	112,405	9	667
1918	106,145	8	641	Total....	2,465,425	542	40,555
1919	109,118	7	96				
1920	109,662	19	201				

[a] High condemnation of whole carcasses and comparatively few parts.
[b] Low condemnation of whole carcasses and high number of parts.

As a result of the heavy condemnation of parts of tuberculosis in 1928 there were numerous complaints from the wholesale dealers. In 1930, the agitation was such that a question arose

as to whether or not the lesions found in the hogs were really due to tuberculosis infection. Verifying the presence of the tubercle bacilli in the lesions, isolating them in pure culture, and identifying the types involved, became the object of the present investigation. Examination of tubercle nodules from the lesions of condemned parts revealed acid-fast organisms. Tissue suspensions from such nodules injected into guinea pigs produced lesions of tuberculosis from which pure cultures of tubercle bacilli were obtained. Thus, the previous reports of tuberculosis at the Manila abattoir were definitely confirmed.

Tuberculin test.—In order to correlate the findings of tuberculosis in swine at the Manila abattoir with the actual prevalence of the disease in natural infection, the intradermal test was applied to fifty-three hogs in Navotas, Rizal, a town just outside Manila, and 35.8 per cent gave positive reactions to tuberculin. Six native pigs at the veterinary research laboratory purchased from Angat, Bulacan, for experimental purposes, were likewise tested, and 50 per cent reacted. When these reactors were autopsied, one showed lesions of generalized tuberculosis while the other two exhibited local lesions in the submaxillary glands. Pure cultures of tubercle bacilli were recovered, and when injected into guinea pigs and rabbits they proved to be uniformly pathogenic.

In view of the alarming incidence of tuberculosis in the human population of Navotas—90 per cent according to health reports—there seemed to be a direct relationship between the infection in man and in swine. This was supported by the observation that all the hogs that reacted to tuberculin were found among animals running at large and none among those kept in pens. The logical assumption was that the animals roaming about contracted the disease through mass exposure to infected human material scattered on the premises. The open privy system generally used in the rural districts offered a constant source of such infected material to which these scavengers had free access. The lack of a meat-inspection system in the municipalities made the existence of a vicious circle not only conceivable but probable.

TYPE OF TUBERCULOSIS IN SWINE

In the United States and other countries the type of tuberculosis affecting swine may be regarded as intimately associated with the dairy and poultry industries. Hull(13) estimates that 75 per cent of tuberculosis in the hogs slaughtered in Chicago

in 1917 was due to the avian type, because the Western States, which furnished most of the hogs, also possessed a well-developed poultry industry with some poultry farms infected with avian tuberculosis. In the Eastern States, however, where the dairy industry was highly developed, the hogs suffered from the bovine type of organisms because many dairy herds were infected with bovine tuberculosis. Calmette(2) observed that the avian type predominated in hogs slaughtered at the abattoir of Buenos Aires, Argentine Republic. In the Philippines the dairy and poultry industries are in their infancy, yet tuberculosis is found in hogs coming from neighboring provinces and slaughtered in Manila. Under the circumstances suspicion logically turns to the human type of infection as the probable source.

Isolation.—Of the materials obtained at the abattoir from swine during the latter part of 1930 and the beginning of 1931, eleven isolations were successful. Due to intercurrent organisms, attempts to obtain pure cultures directly from the lesions, even by the use of various methods of chemical sterilization, failed in many instances. The different technic worked out by Corper and Uyei(4 to 8) for the isolation of tubercle bacilli gave equally varying results. This might be due to difference in the nature of the clinical materials, as these authors confined most of their work to human sputa and body fluids where tissue débris did not appear to be a disturbing factor. Subcutaneous and intraperitoneal injections of macerated nodules into small animals, however, gave rise to uncontaminated lesions of tuberculosis from which pure cultures could be obtained and grown on artificial media.

In this connection Magath and Feldman,(16) in an extensive review of the various cultural methods used in the diagnosis of tuberculosis of known or suspicious materials, concluded that the inoculation of guinea pigs remains the best method of proving the presence of *Mycobacterium tuberculosis* in a given specimen. They stated further that primary cultures in a pure state are more readily obtainable from the guinea-pig lesions than from the original materials. The writer, however, in the case of spleen tuberculosis of swine, was able to secure pure cultures from the infected organ by direct isolation.

Choice of culture media.—By experience, certain media were found to be particularly suitable for certain strains of tubercle bacilli. However, the solid media with plain egg as a basis are known to possess the general requirements, with or without glycerine. Corper and Uyei insist on using their own media,

Petroff(2) considers his medium more suitable, Sweany and Evanoff(22) prefer their milk-cream-egg medium for isolating tuberculosis of bovine origin, Miraglia(17) prefers his medium for human strains, and Griffith,(11) the foremost English worker on tuberculosis, emphasizes the fact that the various modifications of egg media are not superior to plain egg as a stock medium for isolating tubercle bacilli from tissues. Feldman,(10) after a comparative study of various media, concluded that for primary isolation of the human type Miraglia's medium was best, and for the bovine type, the modified medium of Sweany and Evanoff. Herold(12) claims that in his medium colonies may appear as early as five days after direct inoculation with tuberculous human sputum. The report of Lowenstein(15) on his success in cultivating fourteen specimens of urinary sediment from human cases in his medium is interesting, because he claims to have failed to produce infection in three guinea pigs with three samples which were positive in cultures. I have had no experience with this medium. In my hands, Dorset's(9) and Sweany and Evanoff's media have proved satisfactory for obtaining primary cultures from septic materials (Plate 3).

TYPING TUBERCLE BACILLI

Those who have had experience with the work of differentiating the human, bovine, and avian types of tubercle bacilli realize that it is difficult if not impossible to rely upon any one method. Morphological differences as to the appearance of colonies, staining properties of the bacilli, size, shape, etc., are disconcerting. Indeed, under certain conditions of food environments the three types may resemble one another in these respects. Opinion is divided as to what particular method of differentiation is best. Park, Williams, and Krumwiede consider intravenous injection of rabbits a decisive test in differentiating the human and bovine strains. Cobbett(3) has prepared a chart of virulence test in rabbits, guinea pigs, rats, chickens, etc., in order to recognize the three types of tuberculosis. Griffith employs cultural methods on Loeffler's and the various glycerinated media together with virulence test in small animals. More recently Mishulow(18) believes that she can distinguish between the three types of tubercle bacilli by a careful study of colony photographs on plates of Bordet-Gengou and Lowenstein media. According to Toda,(23) of Japan, the skin reaction following intracutaneous injection in rabbits differentiates the

human and bovine strains. In the present study, I have assembled the various methods into four groups; namely, (*a*) typing by cultural method, (*b*) typing by susceptibility tests, (*c*) typing by the intradermal and intravenous injection in rabbits, and (*d*) typing by the character of the morbid changes.

FIRST SERIES

1. *Typing by cultural methods.*—Four strains of the series—TB. 10, TB. 15, TB. 18, and TB. 20—were selected for the first part of this study. The following media were used: Plain agar pH 7.4, glycerine agar pH 7.6, Petroff's medium according to Standard Methods (Wadsworth), ox-bile broth (pure fresh bile) sterilized fractionally, and chicken-bile broth.

Each strain was planted on these media in duplicate sets; one set was incubated at 37° C. and the other at 40° to 42° C. for four weeks before the results were read. Cultures incubated at 37° C. showed successful growth on the solid media but none on the ox- and chicken-bile tubes where the inoculum promptly sank to the bottom of the liquid. This behavior would indicate the human type of tubercle bacilli. The duplicate cultures grown at 40° to 42° C. exhibited doubtful or no growth whatever. This and the fact that there was no growth on chicken bile would indicate that no avian tubercle bacilli were present in the series. No less than six tubes of each medium were used for each strain. Repetition yielded essentially the same result, which is summarized in Table 2.

TABLE 2.—*Cultures incubated at different temperatures.*

AT 37° C. FOR FOUR WEEKS.

TB. strain.	Plain agar.	Glycerine agar.	Petroff's medium.	Ox bile.	Chicken bile.
No. 12	Scanty growth	Heavy growth	Growth	Fat pellicle	Negative.
No. 15	do	do	do	do	Do.
No. 18	Very thin growth	do	Good film	do	Do.
No. 20	Fair	do	Good growth	do	Do.

AT 40° TO 42° C. FOR TWO WEEKS; AT ROOM TEMPERATURE FOR FOUR WEEKS.

No. 12	Growth doubtful	—	—	Fat scum?	Negative.
No. 15	do	—	Doubtful	Fat scum	Do.
No. 18	do	Doubtful	do	Fat scum and sediment.	Do.
No. 20	Few colonies?	do	do	Fat scum	Do.

2. *Typing by susceptibility tests and character of morbid changes.*—Cultures of the four strains were planted on glycerine agar or Petroff's medium and grown for at least six weeks. Depending on the density of growth, one or two slant cultures were emulsified into a paste in glycerine broth in a sterile mortar and then diluted to a suspension equivalent to a standard containing about 0.01 mg per cubic centimeter. Separate sterile syringes and containers were used for each strain. For each strain three rabbits and two guinea pigs were injected both intradermally and intraperitoneally. One rabbit in each test received 0.2 to 0.3 cc intradermally, which according to Toda produces a persistent cutaneous ulcer in a true bovine strain. For controls, three rabbits were injected with a known bovine culture and one guinea pig with a known human strain.

At the end of ten weeks the animals that survived were killed and autopsied. In animals without visible lesions but showing suspicious signs of the disease, the organs were sectioned, stained, and examined for tuberculous lesions. Stained smears from suspected organs were also examined for tubercle bacilli. As a presumptive test of infection, all surviving animals were given the intradermal tuberculin test before being killed. Readings were recorded on a chart according to the intensity of the reaction. There being no history of spontaneous tuberculosis among the animals used, a preinjection tuberculin test was considered unnecessary. Table 3 represents the average result obtained from repeated tests with each strain.

The high virulence to guinea pigs, the benign local effects on rabbits, and the failure to infect chickens strongly indicated that these four strains were human type of tubercle bacilli. Moreover, the skin reaction of Toda in rabbits was uniformly negative with each strain although a slight tuberculin reaction was noted.

SECOND SERIES

1. *Typing by cultural methods.*—For the study of cultural and morphological characters of the seven strains in this series, six to twelve tubes of each medium were used for each strain. In this instance, however, the selective media of Miraglia, Loeffler, Dorset, and Evanoff were employed. Special reliance was placed on the morphology and type of growth on Loeffler's medium and the group of glycerine media as recommended by Stanley Griffith in differentiating the three types of tubercle bacilli. Complete observations are recorded in Table 4.

TABLE 3.—*Typing by susceptibility test in rabbits, guinea pigs, and chickens (first series).*

TB. strain.	Species.	Route of injection.	Tuberculin reaction.	Killed or died.	Post-mortem lesions.
No. 12	Rabbit 1	Intradermal	++	Killed 75 to 81 days after injection	Localized TB.
No. 12	Rabbit 2	Intraperitoneal	+++	do	Do.
No. 12	Rabbit 3	do	++	do	Do.
No. 12	Guinea pig 1	do	+	do	Generalized TB.
No. 12	Guinea pig 2	do	0	Died 15 days after injection	Lymph gland TB.
No. 12	Chicken 1	do	—	Killed 75 to 81 days after injection	Negative TB.
No. 15	Rabbit 4	Intradermal	++	do	Localized TB.
No. 15	Rabbit 5	Intraperitoneal	++++	do	Do.
No. 15	Rabbit 6	do	++++	do	Do.
No. 15	Guinea pig 3	do	0	Died 28 days; after injection	Generalized TB.
No. 15	Guinea pig 4	do	0	Died 33 days after injection	Do.
No. 15	Chicken 2	do	—	Killed 75 to 81 days after injection	Negative TB.
No. 18	Rabbit 7	Intradermal	—	do	No gross lesions.
No. 18	Rabbit 8	Intraperitoneal	+++	do	Localized TB.
No. 18	Rabbit 9	do	—	Died 63 days after injection	Hydropericardium ascites.
No. 18	Guinea pig 5	do	++++	Killed 75 to 81 days after injection	Generalized TB.
No. 18	Guinea pig 6	do	++++	do	Do.
No. 18	Chicken 3	do	++	do	Negative TB.; mummified ovaries.
No. 20	Rabbit 10	Intradermal	—	do	Localized TB.
No. 20	Rabbit 11	Intraperitoneal	++	do	Do.
No. 20	Rabbit 12	do	+	do	Do.
No. 20	Guinea pig 7	do	0	Died 52 days after injection	Cachexia, generalized TB.
No. 20	Guinea pig 8	do	0	Died 71 days after injection	Localized TB.
No. 20	Chicken 4	do	—	Killed 75 to 81 days after injection	Negative TB.
Controls:					
Bovine 22	Rabbit 13	do	0	Died 82 days after injection	Generalized TB.
Bovine 22	Rabbit 14	do	0	Died 65 days after injection	Do.
Bovine 22	Rabbit 15	Intradermal	0	Died 102 days after injection	Generalized TB.; persistent ulcers.
Human (M)	Guinea pig 9	Intraperitoneal	0	Died 56 days after injection	Generalized TB.
Avian (B. S.)	Chicken 5	do	+++	Killed 75 to 81 days after injection	Do.

TABLE 4.—*Cultures on selective solid media incubated at 37° C. from one to two months (second series).*

Strain.	Miraglia's medium.	Loeffler's coagulated serum.	Dorset's medium.	Evanoff's medium.
No. 12.....	Luxuriant, yellow, spreading growth.	Fair growth, dull yellow, granular.	Fair and smooth.	Fair growth, dull in color.
No. 15.....	Very luxuriant, almost orange color; individual colonies raised.	Thin growth, yellowish, warty.	Very fine colonies, yellowish.	Dull white, surface rough, colonies raised.
No. 19.....	Luxuriant growth, yellowish, granular.	Spreading colonies, granular, uniform yellow.	Good growth, smooth surface, spreading.	Dull white, smooth colonies, fine and uniform.
No. 20.....	Very luxuriant, almost orange, colonies rough.	Slight, very fine growth, colonies isolated, yellowish, granular.	Rough, isolated colonies, yellowish.	Dull white colonies, isolated and rough.
No. 21.....	Luxuriant growth, almost orange color, colonies rough.	Thin growth, yellow, warty.	Colonies yellowish, rough, and isolated.	Dull white, isolated colonies.
No. 26.....	Luxuriant, dark yellow, rough and spreading.	Good growth, colonies warty and yellowish.	Scanty growth, fine.	Fair growth.
No. 28.....	Very luxuriant, warty, isolated colonies, almost orange.	Fair growth, yellow, granular.	Good growth, dark yellow, colonies adherent.	Rough, isolated, dull colonies.
No. 29.....	Fair growth, colonies rough and raised, dull yellow.	Good growth, yellow, granular.	Slight growth, colonies rough, yellowish.	Dull white, rough colonies.
No. 30.....	Luxuriant growth, colonies rough, isolated, warty, dull yellow.	Fair growth, warty, yellow.	Rough, isolated, dull colonies.	Dull white, raised colonies.
Control, human (M).	Luxuriant, rough growth, almost orange color.	Fair growth, yellow, granular.	Slight growth, isolated, rough, colonies.	Dull white, slow growth.

It will be observed that growth on the glycerinated medium of Miraglia was luxuriant for all the strains, while on the egg medium of Dorset and the cream medium of Evanoff the growths were either scanty or isolated. The yellow coloration on Loeffler's medium was observed in all strains and is claimed by Griffith as characteristic of human tubercle bacilli. It is interesting to note that in the media here employed, growth was evident after ten to fifteen days of incubation and at the end of one

TABLE 5.—*Typing by susceptibility tests (second series).*

Strain.	Species.	Route of injection.	Tuberculin reaction.	Killed or died.	Post-mortem lesions.
No. 10	Rabbit 10	Intradermal	+	Killed 66 days after inoculation	Localized TB.
No. 10	Rabbit 17	Intraperitoneal	+	Died 30 days after inoculation	Do.
No. 10	Rabbit 18	do	+	Killed 66 days after inoculation	Do.
No. 10	Guinea pig 10	do	+++	Died 58 days after inoculation	Generalized TB.
No. 10	Guinea pig 11	do		Died 27 days after inoculation	Do.
No. 10	Chicken 6	do		Killed 66 days after inoculation	Negative.
No. 19	Rabbit 19	Intradermal	++	do	Localized TB.
No. 19	Rabbit 20	Intraperitoneal	+++	do	Do.
No. 19	Rabbit 21	do	±	do	Do.
No. 19	Guinea pig 12	do		Died 24 days after inoculation	Do.
No. 19	Guinea pig 13	do		Died 36 days after inoculation	Generalized TB.
No. 19	Chicken 7	do		Killed 66 days after inoculation	Negative.
No. 21	Rabbit 22	Intradermal		Died 45 days after inoculation	Localized TB. skin.
No. 21	Rabbit 23	Intraperitoneal	+	Killed 46 days after inoculation	Localized TB.
No. 21	Rabbit 24	do	—	Killed 66 days after inoculation	Do.
No. 21	Guinea pig 14	do	++	do	Do.
No. 21	Guinea pig 15	do	+++	do	Generalized TB.
No. 21	Chicken 8	do		Died 33 days after inoculation	Negative.
No. 26	Rabbit 25	Intraperitoneal	(a)	Died 65 days after inoculation	Localized TB.
No. 26	Rabbit 26	do	(a)	Died 60 days after inoculation	Generalized TB.
No. 26	Guinea pig 16	do	(a)	Died 36 days after inoculation	Do.
No. 26	Guinea pig 17	do	(a)	Died 43 days after inoculation	Do.
No. 26	Chicken 9	do		Died 15 days after inoculation	Negative, tumor of liver.
No. 28	Rabbit 27	Intraperitoneal	(a)	Died 91 days after inoculation	Localized TB.
No. 28	Rabbit 28	do	(a)	Died 78 days after inoculation	Do.
No. 28	Guinea pig 18	do	(a)	Died 65 days after inoculation	Generalized TB.
No. 28	Guinea pig 19	do	(a)	Died 68 days after inoculation	Do.
No. 28	Chicken 10	do		Died 3 days after inoculation	Negative, peritonitis.

No. 29	Rabbit 29	Intraperitoneal	(a)	Died 85 days after inoculation	Localized TB.
No. 29	Rabbit 30	do		Died 69 days after inoculation	Do.
No. 29	Guinea pig 20	do	(a)	Died 65 days after inoculation	Generalized TB.
No. 29	Guinea pig 21	do	(a)	Died 72 days after inoculation	Do.
No. 29	Chicken 11	do	(a)	Killed 60 days after inoculation	Negative.
No. 30	Rabbit 31	Intraperitoneal	(a)	Died 65 days after inoculation	Localized TB.
No. 30	Rabbit 32	do	(a)	Died 85 days after inoculation	Generalized TB.
No. 30	Guinea pig 22	do	(a)	Died 67 days after inoculation	Do.
No. 30	Guinea pig 23	do	(a)	Died 59 days after inoculation	Localized TB.
No. 30	Chicken 12	do	(a)	Killed 63 days after inoculation	Negative.
Controls:					
Human (M)	Rabbit 33	Intradermal	+++	Killed 66 days after inoculation	Localized TB.
Human (M)	Rabbit 34	Intraperitoneal	+++	do	Do.
Human (M)	Rabbit 35	do	(a)	Died 47 days after inoculation	Do.
Human (M)	Guinea pig 24	do	(a)	Died 36 days after inoculation	Generalized TB.
Human (M)	Guinea pig 25	do	(a)	Died 35 days after inoculation	Do.
Bovine 22	Rabbit 36	Intradermal	(a)	Died 96 days after inoculation	Generalized TB.
Bovine 22	Rabbit 37	Intraperitoneal	(a)	Died 63 days after inoculation	Do.
Bovine 22	Rabbit 38	do	(a)	Died 47 days after inoculation	Do.
Bovine 22	Guinea pig 26	do	(a)	Died 45 days after inoculation	Do.
Bovine 22	Guinea pig 27	do	(a)	Died 46 days after inoculation	Do.

[a] No tuberculin test given.

month most of the cultures on Miraglia's and Loeffler's media were in a luxuriant condition. There was pronounced luxuriance, particularly on Miraglia's medium claimed to be selective for the human strain of tuberculosis. The rough, warty, dry nature of the colonies was likewise regularly observed in this medium. The behavior of these seven strains according to the above cultural and morphological observations would indicate that they were of human origin.

2. *Typing by susceptibility tests.*—In conducting tests with the seven strains in this series, a broth suspension of each strain was prepared separately from a six week's culture on Dorset's medium. The concentration was such that each cubic centimeter contained about 0.01 mg of culture. The animals assigned to each strain were injected as follows: One rabbit received 0.2 to 0.3 cc of suspension intradermally; two rabbits were given 1 cc each intraperitoneally; two guinea pigs and one chicken each were injected with 1 cc intraperitoneally. As controls, a suspension of a culture of known human strain and one of a known bovine strain were injected into two respective groups of animals. Those test animals that did not succumb too soon were each inoculated with 0.1 to 0.3 cc of tuberculin intradermally. The reactions in two readings were recorded before the animals were killed. Meticulous care was exercised during inoculations to avoid intercontamination of the various strains being tested. In testing strains 26, 28, 29, and 30 no intradermal injections were given because the animals were allowed to run the entire course of the disease until death. Detailed observations are recorded in Table 5.

As will be noted in the record of results, all seven strains were uniformly fatal to guinea pigs. The rabbits, on the other hand, presented localized lesions only, while the guinea pigs developed a generalized condition. All the chickens remained healthy, and when they were killed no lesions were found. The pathogenic behavior of these seven strains was indicative of the human type of tubercle bacilli and agreed quite well with the action of the known human strain used as a control. Furthermore, no persistent cutaneous ulcers of Toda were observed in any of the rabbits that received the intradermal injection.

3. *Typing by the character of morbid changes.*—It is realized that differentiation by this means is not absolutely specific, but if the collective features of the complete autopsy lesions are considered, with some experience, such differentiation is possible. For example, no matter what the route of administration, a

suitable dose of a pathogenic bovine strain attacks the lungs of the rabbit more frequently and extensively, causing a confluent pulmonary tuberculosis, which results in generalized infection and death. Such a picture is obtained particularly when the infection is permitted to run its entire course until the death of the animal. In the case of an infection with the human strain of tubercle bacilli, the rabbit suffers from a localized type of lesion, and although the lungs become involved, the nodules are few and discrete. The extension of the lesions to other organs does not seem to alter the localized picture. With the seven strains here tested, the morbid changes produced agreed with those brought forth by the known human strain. Likewise, the persistent skin ulcer of Toda proved to be quite specific for the bovine type of bacilli as it affects the rabbit skin, but no such reaction was observed in any of the strains tested (Plates 1 and 2).

COMBINED FIRST AND SECOND SERIES

1. *Typing by intradermal and intravenous injections in rabbits.*—Like the intravenous injection, the intradermal inoculation is for the purpose of differentiating the bovine from the human strains. This method was incorporated in the previous virulence tests (Tables 3 and 5) and the results included therewith. A combined test of the first and second groups was made by the intravenous method and the result summarized in Table 6.

TABLE 6.—*Typing by intravenous injections of rabbits (first and second series).*

Strain.	Species.	Dose of culture.	Killed or died.	Post-mortem lesions.
		cc.		
No. 10	One female rabbit.	1	Killed 43 days after inoculation.	Localized pulmonary TB.
No. 12	do	1	Killed 55 days after inoculation.	Pulmonary TB.
No. 15	do	1	do	Localized pulmonary TB.
No. 18	do	1	Died 41 days after inoculation.	Negative for visible lesions.
No. 19	do	1	Died 28 days after inoculation.	Localized pulmonary TB.
No. 20	do	1	Killed 55 days after inoculation.	Do.
No. 21	do	1	Killed 43 days after inoculation.	Do.
Human (M)	do	1	Killed 55 days after inoculation.	Do.

The most notable feature of typing by the intravenous injection in rabbits was the uniform type of local tuberculosis that developed in the lungs. With a true bovine strain (Park, Williams, Krumwiede, and Griffith) the rabbits die of generalized infection involving the spleen, liver, and kidneys. Such lesions were not observed in any of the rabbits used in the above list.

Intravenous injections of 1 cc of culture suspension (0.01 mg) into rabbits produced only mild tuberculosis of the lungs, which is typical of the effects of injecting the human strain. In connection with the successful infection of tuberculosis in highly susceptible animals, Griffith states that the dosage and the method of inoculation is immaterial, provided that the organisms are virulent. According to the careful experiments of B. Lange (1928) (4) one virulent tubercle bacillus is sufficient to produce infection by inhalation.

DISCUSSION

The meat inspection system established in 1907 under American administration made possible the recognition of a disease condition in swine that proved to be a true tuberculosis infection. Although the system of condemnation was based upon the presence of visible lesions alone and was by no means perfect, such procedure served to safeguard the pork-consuming public. From a practical standpoint, such a method of eliminating actually diseased meat from the public markets served the purpose quite efficiently. It is to be noted, however, that the confirmatory finding of true tuberculosis organisms in such condemned parts did not materialize until quite recently, as a result of the present study.

Tuberculin test on fifty-three hogs at Navotas revealed 35.8 per cent infection while in six hogs of the veterinary research laboratory three, or 50 per cent, reacted. Autopsy of these three animals revealed generalized tuberculosis in one and local tuberculosis of the submaxillary glands in the other two. Tubercle bacilli were present in the smears from lesions of all three animals. These results leave no room for doubt as to actual existence of true tuberculosis infection in native swine.

While the figures of incidence shown by the tuberculin test in Navotas and Angat were very high and apparently did not correspond to the percentage of condemnation on the killing floor at the Manila abattoir, it should be noted that the conditions under which the two results were obtained were totally different. The reactors from the tuberculin test included both the tuber-

culous animals with no visible lesions at autopsy and those that showed visible lesions of a local or generalized character. On the killing floor of the abattoir, on the other hand, diagnosis was based entirely upon the presence of visible gross lesions on the carcass; consequently, occult foci of a microscopic nature in the tissues and minor recesses of the body were beyond the range of such ocular inspection.

Direct isolation of pure tubercle bacilli from tuberculous lesions, whether it be from human beings, cattle, or other animals, has always been a common difficulty among laboratory workers. My experience in this work on pig lesions confirmed this, as in many cases chemical methods were utterly unsuccessful in ridding the infected material of intercurrent organisms. Passage of the tuberculous materials through guinea pigs or rabbits and subsequent recovery of the organisms from the infected organs for cultivation, proved to be the most reliable means of securing uncontaminated cultures of tubercle bacilli. This is supported by the recent extensive review of Magath and Feldman on the subject. One exception, however, was in spleen tuberculosis, where direct isolation could be made with ease, as the tubercle nodules were not contaminated with other microörganisms.

In attempting to classify or type the kind of tuberculosis organisms in the four strains of the first series, the writer was aware of the difficulties involved in such an undertaking. Morphological differences between the human, bovine, or avian types of organisms are so full of discrepancies that any criterion on this basis alone is not conclusive. Cultural behavior in various differential media under different incubation temperatures offered a better method. With this, the results obtained were rather decisive. Among four strains of the first series incubated at 37° C., good growths were secured on glycerine agar and Petroff's inspissated egg, while the result in bile broth was not entirely satisfactory. No growth was seen in chicken-bile media. The growth tendency in these media suggested the behavior of the human type of organisms. Likewise, the absence of growth in the same media incubated between 40° and 42° C. apparently ruled out the presence of the avian type in the series.

The result of the differential test by animal susceptibility conducted with such strains was indicative of the human type. In nearly all cases the guinea pigs either succumbed to the injection

or when killed revealed extensive tuberculosis, while the rabbits suffered only localized lesions, regardless of the route of inoculation. The persistent skin ulcers of Toda were not observed in rabbits receiving intradermal injection, but this reaction was readily demonstrated in the control intradermal rabbit that received the known bovine strain (Plate 2). Moreover, this rabbit died of generalized tuberculosis of the lungs, spleen, liver, and kidneys. Ravenel(21) produced a similar type of infection by subcutaneous injection. The rabbits that received intradermal injections of the control human strain did not die and the skin lesion healed completely (Plate 1). All the chickens used survived, and when killed, were negative for tuberculosis. The known control bovine strain killed all the rabbits in 36, 45, and 60 days respectively, with generalized tuberculosis. The known human type killed the guinea pig in 34 days with generalized tuberculosis. Similarly the control avian strain produced generalized tuberculosis in the chicken injected. Such sweeping evidence from the result of this susceptibility test would fortify the conclusion that these four strains were of human origin. Quite recently Mishulow stated that she could differentiate between the human, avian, and bovine types by colony growths on Bordet-Gengou and Lowenstein plates. This work needs further confirmation.

Observations on seven other strains of a second series on selective solid media as well as the virulence tests conducted on rabbits, guinea pigs, and chickens, generally speaking, resembled those of the other four in the first series morphologically, culturally, and in their essential pathogenic action. Likewise, the character of the lesions produced in rabbits and guinea pigs were similar to those brought about by the injection of a known culture of human tubercle bacilli. This would indicate that the strains of the second series were also of human origin.

The failure to isolate avian or bovine types among the eleven strains in the present study is no criterion that such types do not actually exist in native swine. It is more than likely that a study of hogs kept in a known tuberculous dairy herd in the City of Manila or elsewhere would reveal an infection with the bovine type. Similarly, the avian type of tuberculosis would likely be present among hogs of a known tuberculous poultry farm. Reference has already been made to infection in hogs with the bovine and avian types in large tuberculous dairy and poultry farms in the United States and other countries where these industries are highly developed.

It appears that in the light of the facts thus far advanced, human tuberculosis infection in swine creates a vicious circle and constitutes a detriment to the hog industry and a potential menace to public health. Evidence of an existing relationship between the alarming incidence of tuberculosis in the human population of Navotas, Rizal, and the great prevalence of the disease in swine was brought forth by the result of the tuberculin test in the hogs, a number of which were confirmed by autopsy. Proper disposal of infected human material would go a long way to prevent the spread of the disease among hogs, and in the end contribute indirectly to a successful campaign of tuberculosis eradication in human beings. An efficient meat inspection system in the principal municipalities of the Archipelago is imperative in order to insure clean and wholesome table pork.

CONCLUSION

1. Tuberculosis infection in Philippine swine is hereby definitely established.

2. *Mycobacterium tuberculosis* organisms lightly pathogenic to rabbits but highly so to guinea pigs were isolated from lesions of infected hogs and cultured on artificial media.

3. The result of typing eleven strains herein presented on the basis of their morphology, cultural behavior, and pathogenicity to the small animals employed, strongly indicates that they were of human origin. It does not follow, however, that the avian or bovine strains might not exist in native hogs, for no study was made of animals in known infected dairy or poultry farms.

4. Sufficient evidence was adduced that hogs contract the disease through mass exposure to infected human material because of the open privy system in vogue in the rural districts. This is supported by the high incidence of tuberculosis in hogs running at large.

5. Human tuberculosis in swine is not only a detriment to the hog industry of the country but is also a potential menace to public health in relation to the ultimate eradication of "white plague" in human beings.

6. Proper disposal of infected human material on the one hand and the establishment of an efficient municipal meat inspection system on the other would prevent the spread of infection in hogs and would insure to the public wholesome table pork.

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Thanks are due Dr. J. C. David, the veterinarian in charge of the Manila abattoir, for furnishing tuberculous lesions from the hogs; Dr. E. C. Farinas for the use of some cultures isolated by him from pig specimens; Dr. A. B. Coronel for assistance in carrying out this work; and Dr. E. A. Rodier for reading the manuscript.

ILLUSTRATIONS

PLATE 1

FIG. 1. Skin reaction in rabbit, *a*, after injection of human tubercle bacilli.

2. Lesion magnified about three times; *p*, a shallow ulcer at the point of inoculation which eventually healed.

3. Pulmonary tuberculosis after injection of human tubercle bacilli; *t*, discrete nodules.

PLATE 2

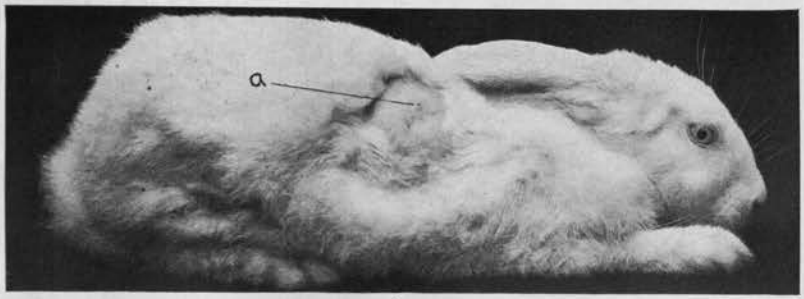
FIG. 1. Skin reaction, *a*, in rabbit after injection of bovine tubercle bacilli.

2. Persistent skin ulcers of Toda, *u*, natural size of fig. 1, *a*.

3. Pulmonary tuberculosis after injection of bovine tubercle bacilli; *t*, confluent tuberculous nodules, involving the two lungs.

PLATE 3

Young primary cultures of tubercle bacilli isolated from swine lesions; Dorset medium.



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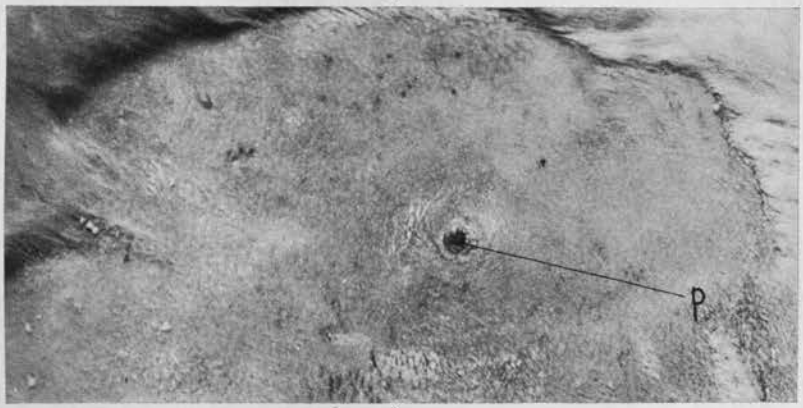

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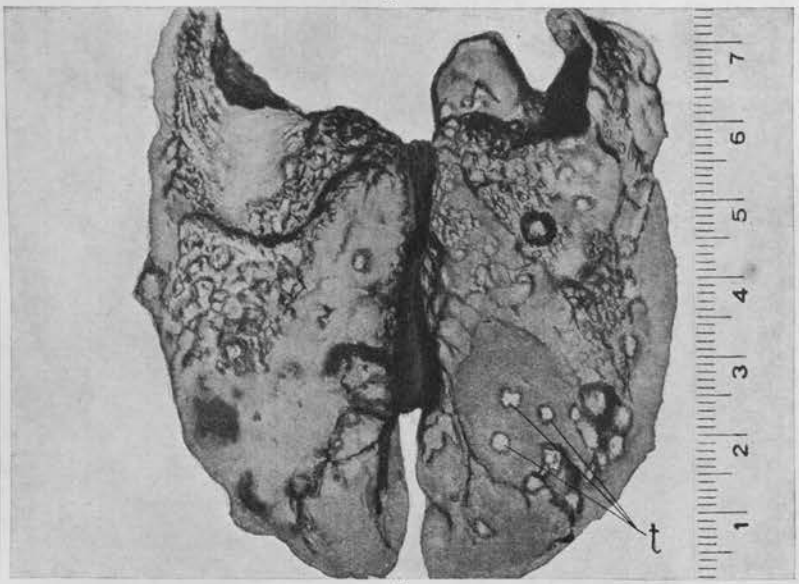

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PLATE 1.

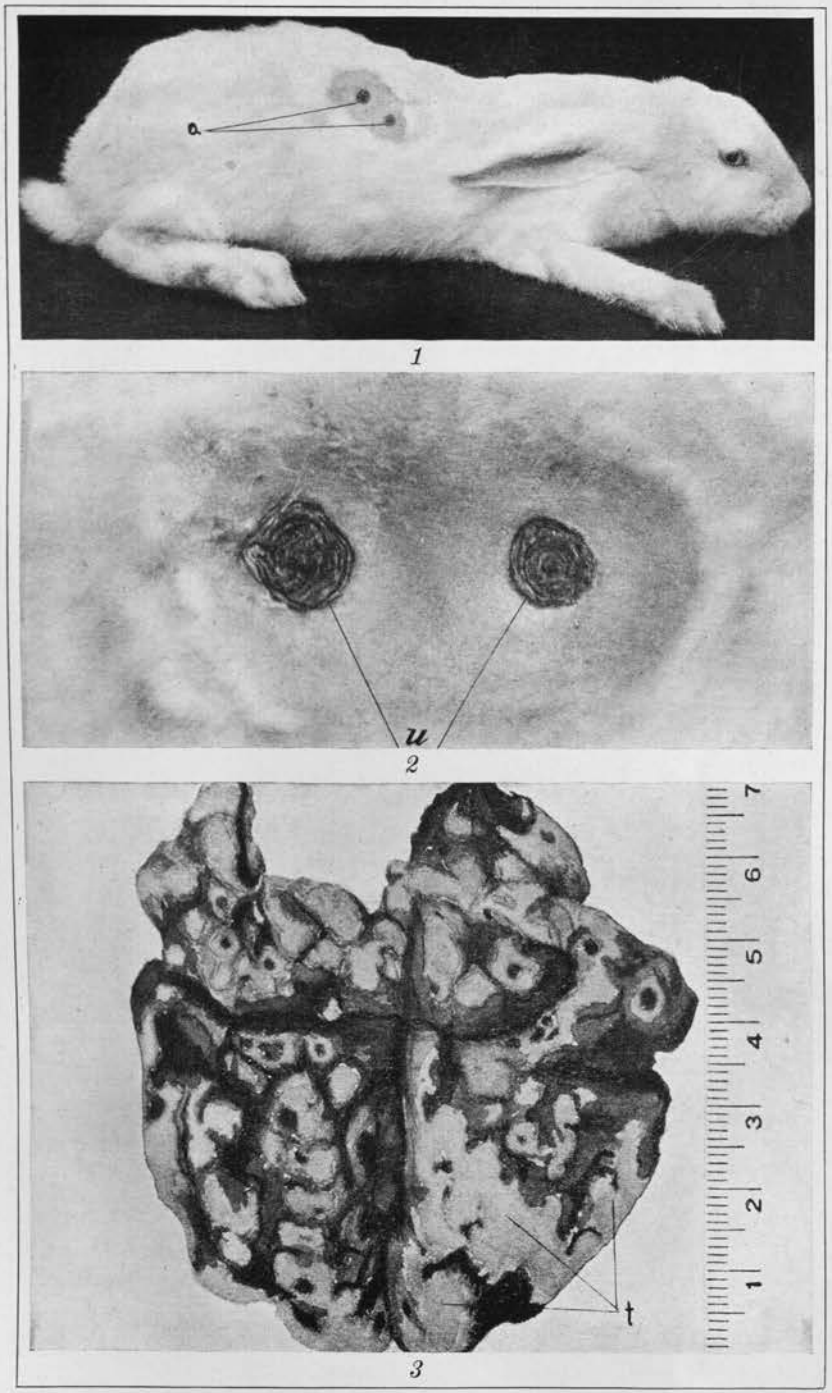

PLATE 2.

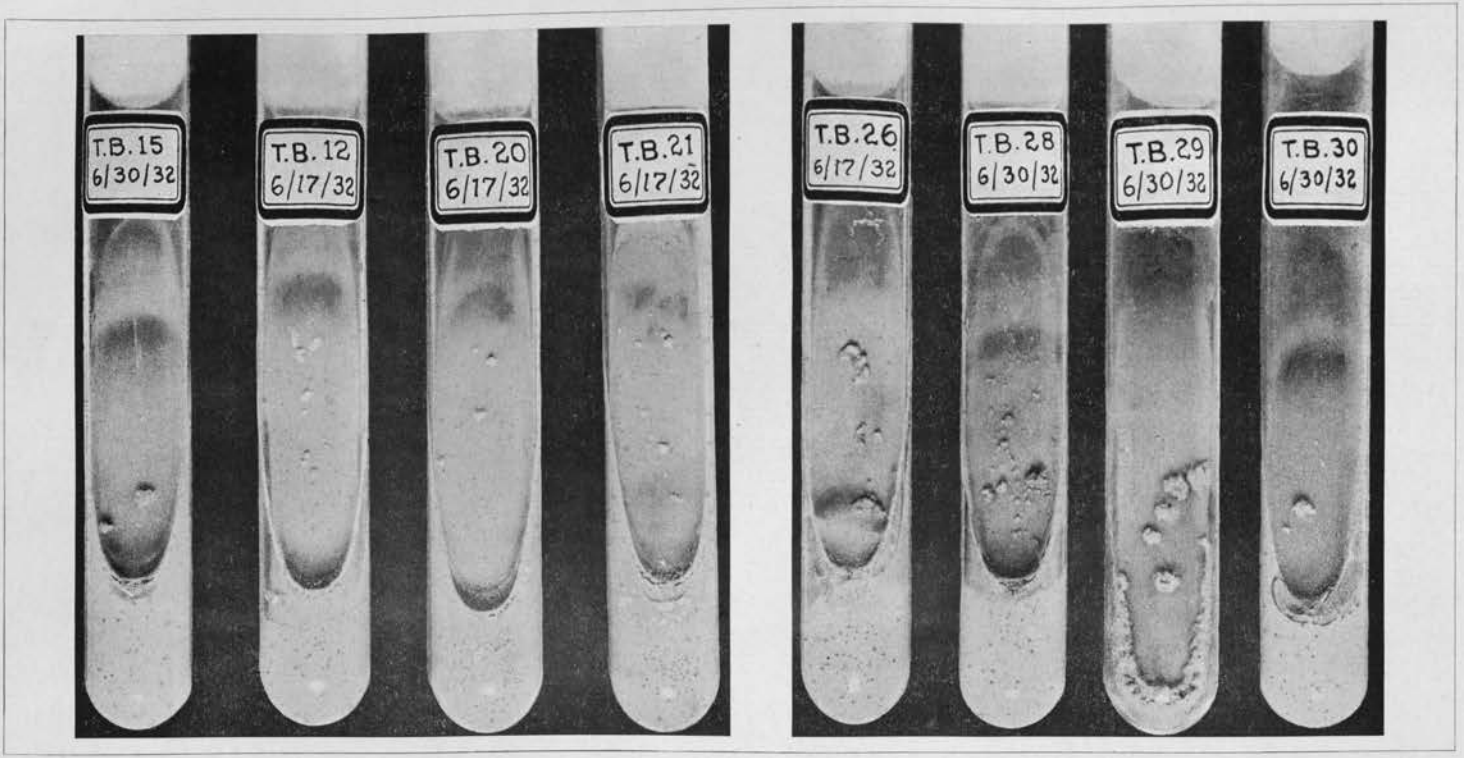
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PLATE 3.

DEVELOPMENT OF THE ANCHOR AND ANCHOR-PLATE TYPES OF SPICULES OF THE SYNAPTID POLYPLECTANA KEFERSTEINII (SELENKA) AND ALLIED SPECIES

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Of the Zoölogical Laboratory, University of the Philippines, Manila

ONE PLATE AND TWO TEXT FIGURES

INTRODUCTION

The growth and development of the calcareous spicules in holothurians is not a new subject of study. However, the writer presents here a description of the spicule formation in *Polyplectana kefersteinii* (Selenka) and other species. In all known holothurians of the order Actinopoda or Pedata the various kinds of spicules, the tables and buttons for example, are derived from an X-shaped fundament (Gerould, 1896). In synaptids, order Paractinopoda or Apoda, the anchor and anchor plate are formed from a simple rod-shaped fundament derived from specialized mesenchymal cells in the connective-tissue layer (Clark, 1907). These calcareous spicules are almost entirely, if not entirely, composed of pure carbonate of lime.

GENERAL DESCRIPTION OF THE ANCHOR AND ANCHOR-PLATE TYPES OF SPICULES

The anchor and the anchor plate, which are usually symmetrical, lie one over the other in the superficial layer of the body wall. The anchor consists of three parts; namely, the posterior stock or handle which is usually expanded; the shaft, a slender rod constituting the body of the anchor and lying with the concave side of the plate; and the anterior arms or appendages, usually meeting at the vertex. The arms are frequently serrated on the outer sides, and when smooth, there are usually several small knobs at the vertex of the anchor. The stock may be finely spinous or branched. In a few rare species the anchor bears arms at both anterior and posterior ends of the shaft. Not

infrequently, the anchors are asymmetrical, one arm being larger than the other. Occasionally there is a third arm.

The anchor plate is more or less concave on the outer side. The posterior end is smaller, with several small holes and, frequently, with an outwardly curved bow which arches the concavity. In the majority of cases the anchor plates are symmetrical, with six or seven serrated or toothed rings. In a few rare species the plates are asymmetrical with numerous small perforations. The anchor plates vary from 0.1 to 1 mm in length. The width varies from one-half to almost equal the length. A plate is always shorter than the anchor that accompanies it.

METHODS OF STUDY

The study of the spicules of *Polyplectana kefersteinii* (Selenka) and other species is very simple because of the thin and transparent body wall. A small piece of the body wall is cut, spread on a slide, slightly pressed under a cover glass, and examined under the microscope. Unlike the thick body walls of other holothurians that of *P. kefersteinii* and other species need not be macerated. All the different stages of anchor and anchor-plate formation, from the earliest to the fully formed spicules, can be seen. Measurements of the different stages of development are taken by means of a micrometer ocular. Measurements are made from different individuals as well as from different regions of one particular individual. The measurements obtained are almost the same in a particular stage of development.

THE DEVELOPMENT OF THE ANCHOR

The anchor develops from a simple dagger-shaped fundament, which is pointed at the posterior end and truncated at the other (Plate 1, figs. 1 and 2). This rod constitutes the shaft or body of the future anchor. In *P. kefersteinii* the youngest rod is 0.1 mm long. The stock of the anchor develops from the pointed, posterior end of the rod, while the arms are formed from the two lateral angles of the truncated, anterior end. The anterior end, which has a width of 0.007 mm, is the anlage of the arms. The study of the different stages of development shows that the shaft and the anlage of the arms gradually increase in length. The pointed end of the shaft remains pointed until the shaft reaches a length of 0.32 mm, when it becomes truncated and flattened. This recently converted, flattened,

posterior end soon expands and develops into the stock or handle of the anchor. The stock grows laterally and gradually up to 0.067 mm, when it becomes finely spinous or branched as the case may be. Long before the appearance of the anlage of the stock, the anlage of the arms has grown laterally, and gives the spicule the appearance of a sword without a handle. When these lateral appendages reach a length of 0.015 mm they begin to curve medially and posteriorly and give the spicule the appearance of an anchor. The arms cease to grow after reaching a length of 0.15 mm and the anchor is considered fully formed excepting for the absence of serrations or finely knobbed teeth. These appear later at the outer edge of the arms or at the vertex. A fully formed anchor in *Polyplectana kefersteinii* has the following measurements:

	mm.
Shaft, length	0.29
Stock, length	0.067
One arm, length	0.15
Anchor, from stock to vertex, length	0.35

The mode of development of the anchor in the four species of synaptids studied—namely, *Polyplectana kefersteinii* (Selenka), *Euapta godeffroyi* (Semper), *Opheodesoma spectabilis* var. *puerto galeræ* var. nov., and *Synapta maculata* (Chamisso and Eysenhardt)—is identical (Plate 1, figs. 13 to 16). Slight differences, however, may be seen in the form of the stock (either spinous or branched), in the curvature of the arms, and in the presence or absence of serrations or knobbed teeth at the vertex or on the arms.

THE DEVELOPMENT OF THE ANCHOR PLATE

The anchor plate starts its development from a very simple rod lying at right angles to the anlage of the shaft. In *Polyplectana kefersteinii* the smallest, and what is considered to be the youngest rod is 0.03 mm long and 0.0037 mm thick (Plate 1, fig. 1). At the earliest stage this rod is truncated at both ends. Later it bifurcates at both ends and assumes the appearance of a double wrench. The original rod constitutes the primary axial rod. Its upper processes after bifurcation become the first primary arms, and the lower processes, the secondary axial rods. Each process gradually increases in length and, after reaching a length of 0.037 mm, divides dichotomously. The first primary arms give off the medial and lateral first secondary arms, while the secondary axial rods give

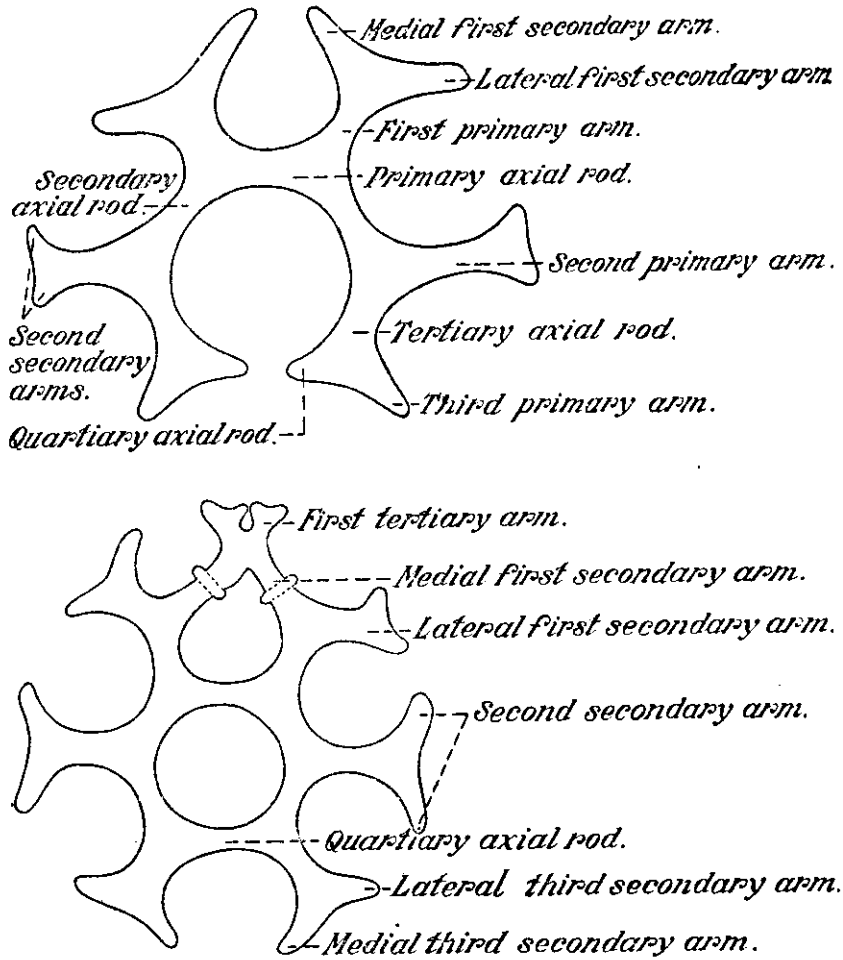

FIG. 1. *Polyplectana kefersteinii* (Selenka); early stages in the development of the anchor plate.

rise to the second primary arms and the tertiary axial rods. The two latter grow up to 0.037 mm long, and each divides dichotomously. The second primary arms give rise to the two second secondary arms, and the tertiary axial rods give rise to the third primary arms and the quartiary axial rods. These branches all grow gradually. The third primary arms divide dichotomously into the two third secondary arms. The two quartiary axial rods after reaching their maximum length fuse and thus form a complete central axial ring with the primary,

secondary, and tertiary axial rods. From this central axial ring extend the three pairs of primary arms.

As the first secondary arms appear first they reach their maximum length first. The two medial first secondary arms fuse together to form an inverted heart-shaped ring from the apex of which two upright branches, the first tertiary arms, arise very close together. These two upright branches divide dichotomously and give rise to smaller branches, the medial ones of which fuse and inclose a small oval cavity. Anterior and lateral to the point of fusion three to four small branches are given

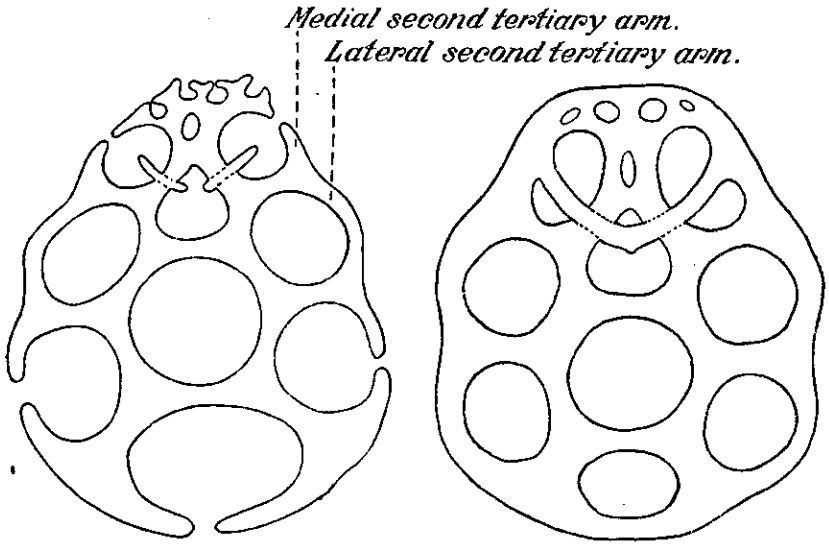

FIG. 2. *Polyplectana kefersteinii* (Selenka); late stages in the development of the anchor plate.

off, each of which divides dichotomously. All these terminal branches fuse and inclose a series of three or four tiny perforations which mark the handle of the plate (text fig. 2).

A thickening appears across the median portion of each medial first secondary arm. These are the anlagen of the bow. These thickenings elongate laterally and medially until they fuse to form a curved bar crossing the apex of the inverted heart-shaped ring. At the same time the lateral first secondary arms divide dichotomously, giving rise to the medial and lateral second tertiary arms (text fig. 2).

The lateral second tertiary arm together with the second and third secondary arms steadily fuse and inclose the five large

peripheral rings that surround the central axial ring. The lateral extensions of the anlagen of the bow at this time also grow laterally to fuse with the outer ring, and divide the two large peripheral rings at the posterolateral sides of the inverted heart-shaped ring into two unequal parts (fig. 2, *b*).

Serrations then appear around the inner margin of the central axial ring and of the five large peripheral rings. The part of the bow that crosses the inverted heart-shaped ring also develops a few serrations at its anterior margin. Then the anchor plate assumes its final form.

The total length of the plates averages 0.22 mm. The maximum width is 0.17 mm. The posterior part, considered to be the handle of the plate, is narrower than the body and measures 0.087 mm.

The development of the anchor and the anchor plate is identical in all the synaptids studied from Puerto Galera. Even in *Synapta maculata*, Plate 1, fig. 20, in which the fully formed anchor plate is very different from that of the other species, the development is of the same plan. Slight modifications only appear later in the irregular ramifications of the tertiary and quartiary arms at the anterior and posterior ends of the plates, which result in the formation of numerous small perforations.

RELATIONS OF THE ANCHOR AND THE ANCHOR PLATE

The anchor and the anchor plate are closely related to each other. They are always found lying one over the other. Even in the earliest stage of development the rod-shaped fundament of the anchor plate is always found lying at right angles to the anlage of the anchor near its anterior end. They do not become separated from each other except through pressure, because they are connected by a loose connective tissue. This is seen when a piece of body wall is mounted on a slide and examined under the microscope. They only become separated from each other when the body wall is macerated.

SUMMARY AND CONCLUSIONS

1. The spicules in synaptids of the order Paractinopoda or Apoda develop from a simple rod-shaped fundament unlike those in holothurians of the order Actinopoda or Pedata, which develop from an X-shaped fundament.

2. The anchor and the anchor plate of synaptids, though different in shape, are both derived from a single straight fundament.

3. In all other species, including *Synapta maculata*, where the anchor plate is very different in shape from the others, the plan of development is the same.

4. The anchor and the anchor plate are closely related to each other and are always found lying at right angles, one over the other, even in the earliest stages. They are bound together by some kind of loose connective tissue.

ACKNOWLEDGMENT

The writer is indebted to Dr. Hilario A. Roxas, head of the Department of Zoölogy, for reading this paper, and to Dr. Leopoldo S. Clemente, of the same department, for some constructive suggestions.

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ILLUSTRATIONS

PLATE 1

FIGS. 1 to 11. *Polyplectana kefersteinii* (Selenka); stages in the development of the anchor and the anchor plate.

FIG. 12. *Polyplectana kefersteinii* (Selenka); miliary granules; *a*, from an adult individual; *b*, from a younger individual.

13. *Euapta godeffroyi* (Semper); fully formed anchor.

14. *Polyplectana kefersteinii* (Selenka); fully formed anchor.

15. *Opheodesoma spectabilis* var. *puerto galeræ* var. nov.; fully formed anchor.

16. *Synapta maculata* (Chamisso and Eysenhardt); fully formed anchor.

17. *Euapta godeffroyi* (Semper); fully formed anchor plate.

18. *Polyplectana kefersteinii* (Selenka); fully formed anchor plate.

19. *Opheodesoma spectabilis* var. *puerto galeræ* var. nov.; fully formed anchor plate.

20. *Synapta maculata* (Chamisso and Eysenhardt); fully formed anchor plate.

TEXT FIGURES

FIG. 1. *Polyplectana kefersteinii* (Selenka); early stages in the development of the anchor plate.

2. *Polyplectana kefersteinii* (Selenka); late stages in the development of the anchor plate.

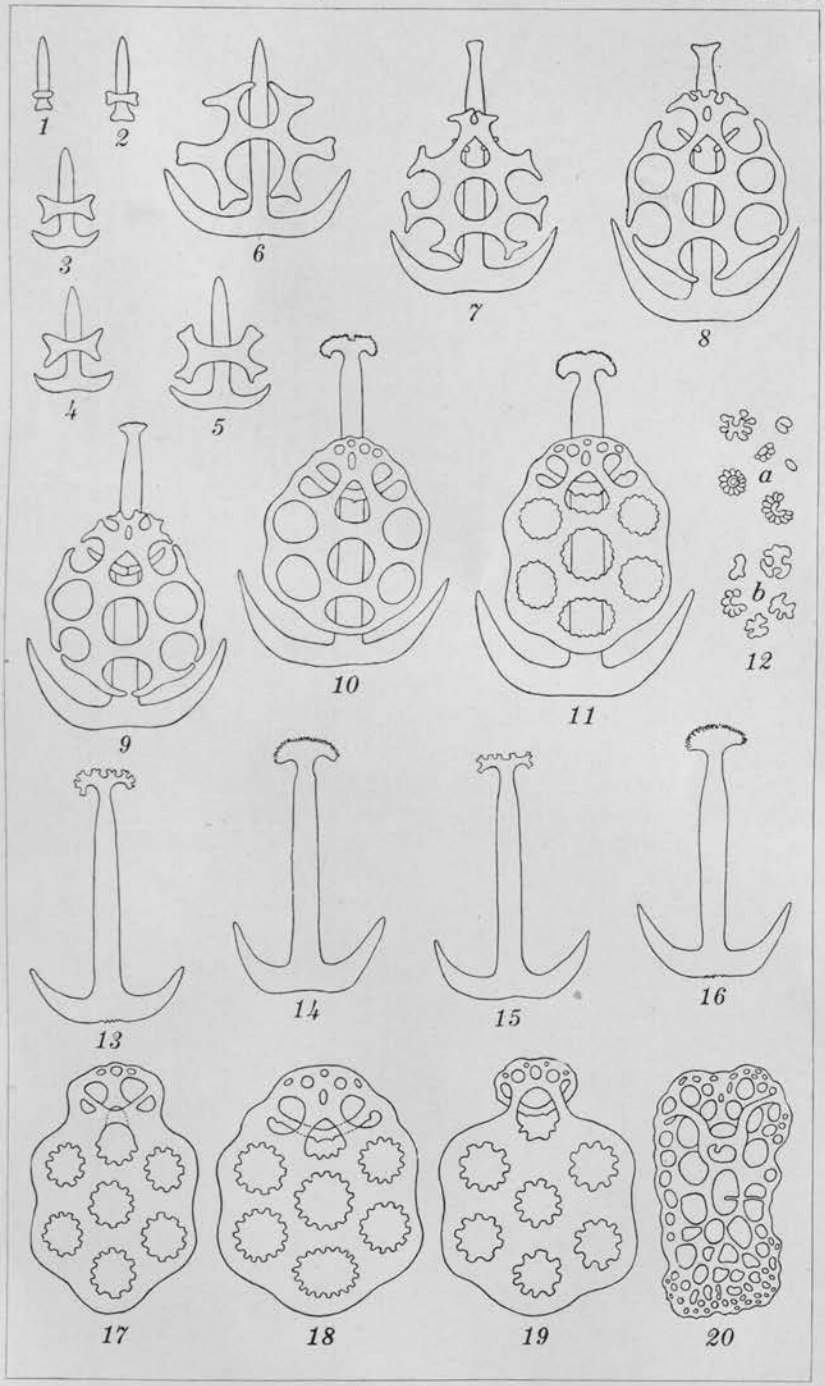

PLATE 1.

NEMATODES PARASITIC IN PHILIPPINE COCKROACHES

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and

M. B. CHITWOOD

Of Glencarlyn, Virginia

THREE PLATES

Through the courtesy of Dr. J. H. Sandground, of the School of Tropical Medicine, Harvard University, the writers have recently had an opportunity to study a small collection of nematodes from *Panesthia javanica,* a cockroach native to the Philippines. This material contained five species, one of which appears to be very close to *Blattophila sphaerolaima* Cobb, 1920, a species that B. G. Chitwood (1932) recently placed in the Thelastomatidæ, as a genus and species inquirenda. For this nematode the writers propose the name *Blattophila sphaerolaima* var. *javanica,* since it differs only in minor respects from the form described by Cobb (1920). The remaining four species appear to be new and represent four genera, three of which have been previously described. One species appears to be most closely related to *Aorurus agile* (Leidy, 1849) but to differ from that species very strikingly. The name *Aorurus philippinensis* is proposed for this species. For two of the species, which appear to belong to the genera *Thelastoma* and *Leidynema,* respectively, the names *Thelastoma palmettum* and *Leidynema nocalum* are proposed.

The fifth species appears to represent a new genus most closely related to *Leidynema,* for which the name *Leidynemella paracranifera* is proposed.

In addition to the foregoing, a description of a new species written by the late Dr. N. A. Cobb is included. Doctor Cobb's notes on nematode parasites of cockroaches were turned over to the writers by his daughter, Miss Margaret V. Cobb. Doctor Cobb had originally intended this species to be the type of a

new genus, with which view the writers agree. However, in view of the absence of figures and some other pertinent data in Doctor Cobb's notes, the writers designate another species as type of the genus. Doctor Cobb's species appears in this paper under the name *Leidynemella fusiformis* Cobb, new species.

Because of certain changes made necessary in the diagnoses of the genera belonging to the subfamily Thelastomatinæ, due to the discovery of the new species described in this paper, it is desirable to formulate a new key to the genera of this subfamily.[1]

Genus BLATTOPHILA Cobb, 1920

Generic diagnosis.—Thelastomatinæ: Oral opening surrounded by eight labiopapillæ; amphids represented externally by small round openings at level of labiopapillæ. Lateral alæ absent. Buccal cavity short and wide, partially surrounded by anterior end of œsophagus and having at base six cuticular thickenings serving as points of attachment for muscles. Œsophagus consists of (1) a clavate corpus distinctly enlarged at anterior end in form of a subspherical swelling, and (1*a*) a posterior part slightly swollen but not set off, (2) a short, narrow, isthmus, and (3) a bulb. Excretory pore posterior to base of œsophagus. Intestine dilated at anterior end; cœcum absent. Tail of male truncate, conical, bearing two large preanal submedian papillæ adjoining anus, and two similar postanal papillæ, one-third of a body diameter, posterior to anus. Spicule represented by a rudimentary point. Tail of female filiform and spinelike. Vulva anterior to middle of body. Eggs ellipsoidal.

Type species.—*Blattophila sphaerolaima* Cobb, 1920.

BLATTOPHILA SPHAEROLAIMA var. JAVANICA var. nov. Plate 1, figs. 1 to 3.

Specific description.—Blattophila:

Male unknown.

Female (nongravid) 2.5 to 2.63 mm long by 250 to 273 μ in maximum width. Cuticle coarsely annulated; annules 8 to 10 μ wide near head and 26 to 28 μ wide at mid-region of body. Buccal cavity short, subtriangular in cross section, inclosed in anterior end of œsophagus and provided with two subdorsal and

[1] It appears necessary, according to the rules of the International Commission on Zoölogical Nomenclature, to emend the spelling of the names Thelastomidæ Travassos, 1929, and Thelastominæ Travassos, 1920, the correct names being Thelastomatidæ Travassos, 1929, emend., and Thelastomatinæ Travassos, 1920, emend.

four subventral cuticular thickenings at base (presumably the "apophyses" of Cobb). Œsophagus 410 to 610 μ long; cephalic swelling of œsophagus 33 to 50 μ long by 35 to 44 μ wide, corpus 280 to 360 μ long with a minimum diameter of 34 to 40 μ and a maximum diameter of 56 to 70 μ; isthmus 30 to 40 μ long by 28 to 30 μ wide; bulb 100 to 120 μ long by 80 to 97 μ wide. Nerve ring not observed. Excretory pore immediately posterior to base of œsophagus. Intestine thick-walled with a short dilated part, posterior to œsophageal bulb. Anus 590 to 670 μ from posterior end of body. Phasmids slightly posterior to anus. Tail filiform, spicate. Vulva 550 to 750 μ from anterior end of body, 21 to 23.6 per cent of body length from anterior end. Vagina directed posteriorly, true vagina (cuticularly lined) approximately 130 μ long; origin of uteri uncertain; two ovaries, directed posteriorly, reflexed. Eggs not observed.

Host.—*Panesthia javanica.*

Location.—Presumably intestine.

Type locality.—Philippine Islands.

Type specimen.—United States National Museum helminthological collection No. 33045; paratypes No. 33046.

The structure of this nematode appears to agree with the original description of *Blattophila sphaerolaima* Cobb, with the following exceptions: (*a*) The vulva is relatively farther anterior than in Cobb's specimens (21 to 23.6 per cent as against 28 per cent); (*b*) the cuticular annules at the anterior end of the body are wider (8 to 10 μ wide as against 3 μ wide); and (*c*) the cuticular annules are wider in the mid-region of the body (26 to 28 μ wide as against 24 μ wide). The writers do not consider any of these characters sufficient for the erection of a species in the present case, since these measurements are based upon only two specimens, and the reader may see from the variation in the above measurements that additional specimens might readily increase the range.

Genus AORURUS Leidy, 1849

Generic diagnosis.—Thelastomatinæ: Oral opening surrounded by an external circle of eight equal labiopapillæ or papillæ. Amphids represented externally by small round or oval openings at level of external circle of papillæ. Buccal cavity very short and wide. Œsophagus with short, thick corpus in female, forming a pear-shaped swelling; isthmus short or long. Excretory pore near base of œsophagus or posterior to base of œsophagus. Intestine without cæcum. Tail of male filiform.

Genital papillæ consisting of two pairs of papillæ just anterior to anus, one pair more or less fused; one pair of partially fused postanal papillæ, just posterior to anus; and one pair of papillæ on tail. Spicule absent. Testis reflexed. Tail of female filiform (more spinelike). Vulva either near middle of body or near anus; vagina directed anteriorly, uteri divergent, ovaries reflexed. Eggs ellipsoidal; polar cap apparently absent.

Key to the species of the genus Aorurus.

Corpus of female approximately one-half total length of œsophagus; isthmus very short, merely a constricted region between corpus and bulb; vulva just anterior to anus ..... *A. agile.*

Corpus of female approximately one-third total length of œsophagus; isthmus approximately three-eighths total length of œsophagus; vulva near middle of body ..... *A. philippinensis* sp. nov.

The genus *Aorurus* was originally proposed for two species, *A.* (*Streptostoma*) *agile* Leidy, 1849 and *A.* (*Thelastoma*) *attenuatum* Leidy, 1849. Subsequently the subgenus *Thelastoma* was raised by Leidy (1853) to generic rank and later *Blattophila sphaerolaima* Cobb, 1920 was placed in the genus *Aorurus* by Travassos (1929). As will be seen later, this decision was in error. *Aorurus subcloatus* Christie (1931) has been shown to be a synonym of *Aorurus agile* (Leidy, 1849) (see Chitwood, 1932). *Aorurus diesingi* (Hammerschmidt, 1838) Travassos, 1929 was made the type of a new genus *Hammerschmidtiella* by Chitwood (1932). The new species *Aorurus philippinensis* necessitates a somewhat revised conception of the genus *Aorurus* since the vulva is in the middle of the body instead of in front of the anus, as is the case in the type species. The females of these two genera may be distinguished by the structure of the œsophagus, since in both species of *Aorurus* the entire corpus enters into the formation of the corporeal swelling, there being no distinguishable differentiation between the anterior and posterior parts of the corpus, while in *Hammerschmidtiella* only the posterior part of the corpus forms the swelling, the anterior and posterior parts being, therefore, easily differentiated.

AORURUS PHILIPPINENSIS sp. nov. Plate 2, figs. 7 to 11.

Specific description.—Aorurus:

Male unknown.

Female 4 to 4.45 mm long by 165 to 270 μ in maximum width, widest specimen somewhat flattened. Cuticle both annulated and striated. Head distinctly set off by a deep annulation followed by a long, modified first annule of body (Plate 2, fig. 9),

posterior to which the cuticle is coarsely annulated and inflated; annules 17 to 35 μ wide; each annule finely striated, striæ 2 to 5 μ apart; annules gradually becoming less distinct in mid-region of body. Oral opening hexangular, apices of angles submedian and lateral rather than median and sublateral. Cephalic papillæ apparently consisting of an internal circle of six rudimentary papillæ and an external circle of eight well-developed simple papillæ. Œsophagus 473 to 540 μ long, consisting of a pear-shaped corpus, 160 μ long with a minimum diameter of 56 to 60 μ and a maximum diameter of 84 to 110 μ; a narrow isthmus 216 to 260 μ long by 35 to 40 μ wide; and a bulb 130 μ long by 120 to 124 μ wide. Nerve ring posterior to base of corpus. Excretory pore 840 μ from anterior end of body. Intestine dilated at base of œsophagus. Anus 735 to 800 μ from posterior end of body. Tail filiform (spicate). Phasmids approximately one-half of a body diameter posterior to anus. Vulva 1.82 to 2.18 mm from anterior end of body; prominent, anterior lip projected posteriorly; true vagina 150 to 160 μ long, lined with cuticle; uterine vagina about 250 μ long; uteri divergent; anterior ovary directed posteriorly and reflexed anteriorly, posterior ovary directed anteriorly and reflexed posteriorly. Eggs ellipsoidal, 164 to 166 μ long by 70 to 80 μ wide.

Host.—Panesthia javanica.

Location.—Presumably intestine.

Type locality.—Philippine Islands.

Type specimen.—United States National Museum helminthological collection No. 33047; paratypes No. 33048.

This species differs from *A. agile* in that the corpus is proportionately shorter than in *A. agile*, the isthmus is proportionately much longer, the excretory pore is situated farther posterior, and the vulva is situated more anterior than in *A. agile*.

THELASTOMA PALMETTUM sp. nov. Plate 1, figs. 4 to 6.

Specific description.—Thelastoma:

Male unknown.

Female (nongravid) 1.12 to 1.92 mm long by 140 to 150 μ maximum width. Oral opening subtriangular, surrounded by an external circle of eight labiopapillæ; internal circle not observed. First annule 42 to 53 μ wide; remaining annules 8 to 10 μ wide. Buccal cavity short and wide, containing one dorsal and two subventral anteriorly projecting cuticular structures shaped somewhat like palm leaves. Œsophagus 618 to 636 μ long, consisting of a corpus 440 to 550 μ long by 20 μ wide,

an isthmus 32 μ long by 16 μ wide, and a bulb 60 μ long by 60 μ wide. Nerve ring 220 μ and excretory pore 450 μ from anterior end of body (observed in only one specimen). Intestine distinctly enlarged at anterior end. Anus 560 to 680 μ from posterior end of body; tail attenuated, becoming filiform. Vulva 772 μ to 1.0 mm from anterior end of body; vagina directed anteriorly; uteri divergent, anterior ovary directed posteriorly and reflexed anteriorly; posterior ovary directed anteriorly, reflexure not observed.

Host.—*Panesthia javanica.*

Location.—Presumably intestine.

Type locality.—Philippine Islands.

Type specimen.—United States National Museum helminthological collection No. 33049; paratypes No. 33050.

This species may be differentiated from other known species of the genus *Thelastoma* by the characteristic palm-leaflike cuticular projections in the buccal cavity. While it is probable that homologous structures are present in other species of the genus, no species is known to have such an elaborate formation.

LEIDYNEMA NOCALUM sp. nov. Plate 2, figs. 12 and 13; Plate 3, figs. 14 to 17.

Specific description.—Leidynema:

Male 1.1 to 2.33 mm long by 80 to 100 μ wide. Cuticular bosses and alæ apparently absent. Oral opening hexangular, surrounded by an internal circle of six small papillæ and an external circle of eight large papillæ. Amphids lateral, porelike. Buccal cavity short, subtriangular in cross section. Œsophagus 290 to 294 μ long; the anterior part of corpus 100 to 104 μ long by 18 to 24 μ wide, posterior part 60 μ long by 30 to 36 μ wide; isthmus 38 to 50 μ long by 8 to 10 μ wide; bulb 80 μ long by 54 to 70 μ wide. Nerve ring and excretory pore not observed. Anus 590 to 600 μ from posterior end of body; tail attenuated, becoming filiform. Caudal papillæ consisting of one pair of large preanal papillæ, one pair of small adanal papillæ, a medioventral postanal organ, and a pair of postanal papillæ near anus. Short, narrow, preanal subventral alæ. Spicule absent.

Female (nongravid) 1.84 to 2.2 mm long by 80 to 100 μ wide. Lateral alæ absent. Oral opening subtriangular; internal circle of papillæ not observed; external circle consisting of eight labiopapillæ; amphids oval. Buccal cavity and œsophagus shaped as in male. Œsophagus 240 to 260 μ long; anterior part of corpus 100 μ long by 22 μ wide, posterior part 60 μ long by 40 μ wide; isthmus 30 μ long by 22 μ wide; and bulb 50 μ long by

70 μ wide. Intestine without cæcum or posterior twist. Anus 520 to 560 μ from posterior end of body. Tail finely attenuated, not set off from body. Vulva 600 to 650 μ from anterior end of body; uteri apparently first parallel, directed anteriorly, then divergent.

Host.—Panesthia javanica.

Location.—Presumably intestine.

Type locality.—Philippine Islands.

Type specimens.—United States National Museum helminthological collection No. 33051; paratypes No. 33052.

The most outstanding character by which *L. nocalum* may be distinguished from the remaining species of the genus *Leidynema* is the presence of a distinct posterior swelling of the corpus in both sexes. Previously, no species of thelastomid has been described in which the œsophagus of the male possesses a corporeal swelling. The similarity of the œsophagus of thelastomid males [that is, *Aorurus agile* (syn. *A. subcloatus*) as shown by Christie, 1931] to that of the larvæ of females rather than to the adult, as well as the sexual dimorphism of cephalic characters, have led to the conclusion that most thelastomid males may be considered precocious larvæ. In this connection, it is interesting to note that *L. nocalum* is the first species found in which the œsophagus is identical in both sexes; there is also much less sexual dimorphism in cephalic characters.

The female of *L. nocalum* may be differentiated from females of other species of the genus through the proportionately greater length of the isthmus which is indicated by only a very short constriction in other members of the genus. Further differentiation of the species is shown in the following key.

Key to the species of the genus Leidynema.

1. Buccal cavity subcylindrical, twice as long as wide..... *L. craniferum.*
   Buccal cavity not longer than wide..... 2.
2. Lateral alæ of female large, terminating posteriorly in paired lateral spines ..... *L. appendiculatum.*
   Lateral alæ of female narrow or absent, not terminating in paired lateral spines ..... 3.
3. Tail of female short and conical with only slight attenuation. *L. delatorrei.*
   Tail of female long and finely attenuated..... *L. nocalum.*

Genus LEIDYNEMELLA gen. nov.

Generic diagnosis.—Thelastomatinæ: Male unknown in type species. In known species, one testis, reflexed, tail very ab-

ruptly set off from remainder of body, appearing as a dorsal appendage. Spicule single. Caudal papillæ consisting of one pair of preanal papillæ near anus, one medioventral postanal papilla, and a pair of subdorsal postanal papillæ near anus. Female with narrow lateral alæ; cuticular annulations small but conspicuous. Oral opening surrounded by eight submedian labiopapillæ; amphids lateral, small. Buccal cavity short, prismoidal. Œsophagus consisting of (1) a long narrow corpus terminated by (1*a*) a subspherical swelling, (2) a distinctly set-off isthmus, and (3) a bulb. Nerve ring apparently surrounding middle of corpus. Excretory pore not observed. Intestine dilated anteriorly, then becoming narrow; diverticula absent. Tail filiform. Vulva approximately half way from head to anus; vagina directed posteriorly; uteri apparently divergent. Egg not observed.

Type species.—*Leidynemella paracranifera* sp. nov.

The genus *Leidynemella* appears to be most closely related to the genus *Leidynema* but differs from the latter in that the swelling at the base of the corpus is subspherical rather than subcylindrical. The type species, *L. paracranifera* sp. nov., resembles *Leidynema craniferum*, but differs from that species chiefly in the shape of the corporeal swelling. The writers have also placed in the new genus *Leidynemella* the species *Oxyuris panesthiæ* Galeb, 1878 [=*Leidynemella panesthiæ* (Galeb, 1878) new comb.] and *Leidynemella fusiformis* Cobb sp. nov. These three species agree in the character of the œsophagus.

LEIDYNEMELLA PARACRANIFERA sp. nov. Plate 3, figs. 18 and 19.

Specific description.—*Leidynemella:*

Male unknown.

Female (nongravid) 1.6 mm long by 120 μ wide. Lateral alæ not terminated posteriorly by spines. Cuticular annules 10 μ wide in mid-region of body; head set off as three modified annules (see fig. 18); cephalic papillæ as in *Leidynema craniferum*. Buccal cavity prismoidal, bearing cuticular thickenings near base. Œsophagus 226 μ long; anterior part of corpus 130 μ long by 16 μ wide, posterior part 30 μ long by 28 μ wide; isthmus 30 μ long by 12 μ wide; bulb 36 μ long by 32 μ wide. Nerve ring apparently 100 μ from anterior end of body. Anus 630 μ from posterior end of body. Vulva 450 μ from anterior end of body.

Host.—*Panesthia javanica.*

Location.—Presumably intestine.

Type locality.—Philippine Islands.

Type specimen.—United States National Museum helminthological collection No. 33053.

Leidynemella paracranifera differs from *Leidynemella panesthiæ* in that the vulva is near the middle of the body, exclusive of the tail, in the new form, while it is definitely posterior to the middle of the body, exclusive of the tail, in the latter species. The two species may be further differentiated by the relative length of the anterior part of the corpus and isthmus. In *L. panesthiæ* the istmus is three-fourths as long as the anterior part of the corpus, while in *L. paracranifera* the isthmus is only ten forty-thirds as long as the anterior part of the corpus.

LEIDYNEMELLA FUSIFORMIS N. A. Cobb,[2] sp. nov.

Specific description.—Leidynemella:

Male more slender and less fusiform than female. Œsophagus not described; presumably as in female. Tail set off from body by abrupt diminution in size, almost as if attached as an appendage to the dorsal side of a terminal anus; it is only two to five times as long as neck but like that of female, is slender and pointed. Caudal papillæ consisting of two subventral preanal papillæ near anus, one medioventral postanal papilla near anus, and two subdorsal papillæ near anus. Testis extending one-half distance from anus to base of œsophagus; reflexed. Spicule straight, linear, equal to anal body diameter in length. Caudal alæ absent.

Female $\frac{.8 \quad 11. \quad 15.5 \quad 27. \quad 57.}{1.2 \quad 4.1 \quad 5.2 \quad 7.1 \quad 3.}$ 1.5 mm long by 106 μ wide. Striæ plain, transverse, giving contour of worm a crenate appearance, changing somewhat in cervical region to become almost retrorsely serrate. Striæ 2.3 μ apart in cervical region; 3 to 5 μ apart near middle of body. Neck conoid; two prominent pointed lateral retrorse spines, situated one-half to three-fifths distance from anterior end to swelling at base of corpus; lateral alæ terminated posteriorly by paired lateral spines opposite anus. Appearance of head varying widely dependent upon whether it is at rest or in action. Generally appearing somewhat truncate and not expanded, but appearing to contain a hollow sphere through which the lining of the œsophagus is seen to pass. Head, however, often appearing swollen as if wearing a fez or a crown. In this condition the organs ordinarily seen to lie inside the head are everted. Cephalic setæ,

[2] Description by N. A. Cobb; edited by the present writers.

papillæ, eye spots, and amphids not observed. Buccal cavity resembling that of *Diplogaster*, half as deep as head is wide and two-thirds as wide as deep; this does not apply to the ordinary appearance of the buccal cavity when the parts are at rest, but to the everted condition. Distance to base of œsophagus 232 μ. Œsophagus resembling that of *Diplogaster*, having a median and a cardiac bulb, both well developed; subspherical median bulb at beginning of posterior third of œsophagus, two-thirds as wide as corresponding part of neck; posterior bulb nearly spherical, larger, two-thirds as wide as base of neck, containing a large and elaborate valve; isthmus one-fifth to one-fourth as wide as corresponding part of neck and somewhat longer than cardiac bulb. Nerve ring 165 μ from anterior end of body. Excretory pore not observed. Narrow, deep, and distinct cardiac column between colorless intestine and œsophagus; intestine dilated at anterior end. Rectum hardly as long as anal body diameter. Anus 755 μ from posterior end of body; tail diminished very suddenly, on ventral side a little behind anus, very soon becoming only one-half as wide as at anus; tapering to a point. Vulva 305 μ from anterior end of body; vagina directed anteriorly, reflexed posteriorly; uteri extending backward to vicinity of anus then reflexed. Ovaries half as long as body of worm, blind ends lying near vulva. Eggs thin-shelled, 90 to 100 μ long by 36 μ wide, slightly curved, segmented; approximately 12 in number.

Host.—*Panesthia laevicollis* (?).

Location.—Intestine.

Type locality.—Moss Vale, New South Wales, Australia (1894).

Type specimens.—Probably lost.

Leidynemella fusiformis differs from *L. panesthiæ* in that the vulva is anterior to the middle of the body, exclusive of the tail, and lateral alæ terminating in spines are present in the female, none having been described in *L. panesthiæ*. *Leidynemella paracranifera* may be differentiated from *L. fusiformis* by the apparent absence of spinate terminations of the alæ as well as by the greater width of the annules, which are 10 μ wide in the middle of the body, while those of *L. fusiformis* are only 3 to 5 μ wide.

The differences of the three species of the genus *Leidynemella* are shown in the following key.

Key to the species of the genus Leidynemella.

1. Vulva posterior to middle of body (exclusive of tail).... *L. panesthiae.*
   Vulva anterior to or near middle of body, exclusive of tail..... 2.
2. Lateral alæ of female terminating anteriorly and posteriorly as spinate processes; cuticular annules not over 5 μ wide..... *L. fusiformis.*
   Lateral alæ not terminating in spinate processes; cuticular annules 10 μ wide near middle of body..... *L. paracranifera.*

For the purpose of differentiating the genera at present included in the subfamily Thelastomatinæ, the following key is appended.

Key to the genera of the subfamily Thelastomatinæ.

1. Corpus of œsophagus terminated posteriorly by a pronounced swelling, at least in female ..... 2.
   Corpus of œsophagus not terminated by pronounced swelling..... 5.
2. Anterior and posterior parts of corpus not distinctly set off.... *Aorurus.*
   Anterior and posterior parts of corpus distinctly set off..... 3.
3. Corpus terminated by a subcylindrical swelling..... *Leidynema.*
   Corpus terminated by an ovoid or subspherical swelling..... 4.
4. Buccal cavity well developed; corpus terminated by a subspherical swelling ..... *Leidynemella.*
   Buccal cavity extremely small and short; corpus terminated by an ovoid swelling ..... *Hammerschmidtiella.*
5. Eggs encapsulated or covered with spiral threads (often in two's or three's) ..... 6.
   Eggs not covered as above ..... 7.
6. Eggs covered by spiral threads ..... *Pseudonymus.*
   Eggs encapsulated, not covered by spiral threads..... *Binema.*
7. Corpus of œsophagus of female very short, club-shaped..... *Blatticola.*
   Corpus of œsophagus of female not very short, not club-shaped..... 8.
8. Corpus distinctly enlarged in form of a subspherical swelling at base of buccal cavity ..... *Blattophila.*
   Corpus subcylindrical, without any form of distinct enlargement..... 9.
9. Tail conical or nearly conical in both sexes..... 10.
   Tail filiform, attenuated then delicately filiform, or very sharply set off in both sexes ..... 11.
10. Head of female with dorsodorsal and ventroventral simple papillæ and laterodorsal and lateroventral labiopapillæ..... *Severianoia.*
    Head of female with all eight cephalic papillæ in form of labiopapillæ. *Cephalobellus.*
11. Female with one ovary..... *Galebia.*
    Female with two ovaries ..... 12.
12. Tail of female in form of a short appendage..... *Suifunema.*
    Tail of female filiform or very delicately attenuated..... 13.
13. Oral opening surrounded by three lips..... *Fontonema.*
    Oral opening not surrounded by three lips..... 14.

14. Tail of male extremely short, degenerate..... *Euryconema.*
Tail of male delicately attenuated or filiform..... *Thelastoma.*

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ILLUSTRATIONS

PLATE 1

BLATTOPHILA SPHAEROLAIMA VAR. JAVANICA VAR. NOV.

FIG. 1. Female, head, en face view.
2. Female, œsophageal region, dorsoventral view.
3. Female, tail, lateral view.

THELASTOMA PALMETTUM SP. NOV.

FIG. 4. Female, head, en face view.
5. Female, head, dorsoventral view.
6. Female, anal region, oblique lateral view.

PLATE 2

AORURUS PHILIPPINENSIS SP. NOV.

FIG. 7. Female, head, en face view.
8. Female, head, oblique lateral view.
9. Female, œsophageal region, lateral view.
10. Female, tail, lateral view.
11. Egg.

LEIDYNEMA NOCALUM SP. NOV.

FIG. 12. Female, head, en face view.
13. Male, head, en face view.

PLATE 3

LEIDYNEMA NOCALUM SP. NOV.

FIG. 14. Male, head, lateral view.
15. Male, œsophageal region, dorsoventral view.
16. Male, tail, lateral view.
17. Male, region of cloaca, ventral view.

LEIDYNEMELLA PARACRANIFERA GEN. ET SP. NOV.

FIG. 18. Female, head, lateral view.
19. Female, œsophageal region, dorsoventral view.

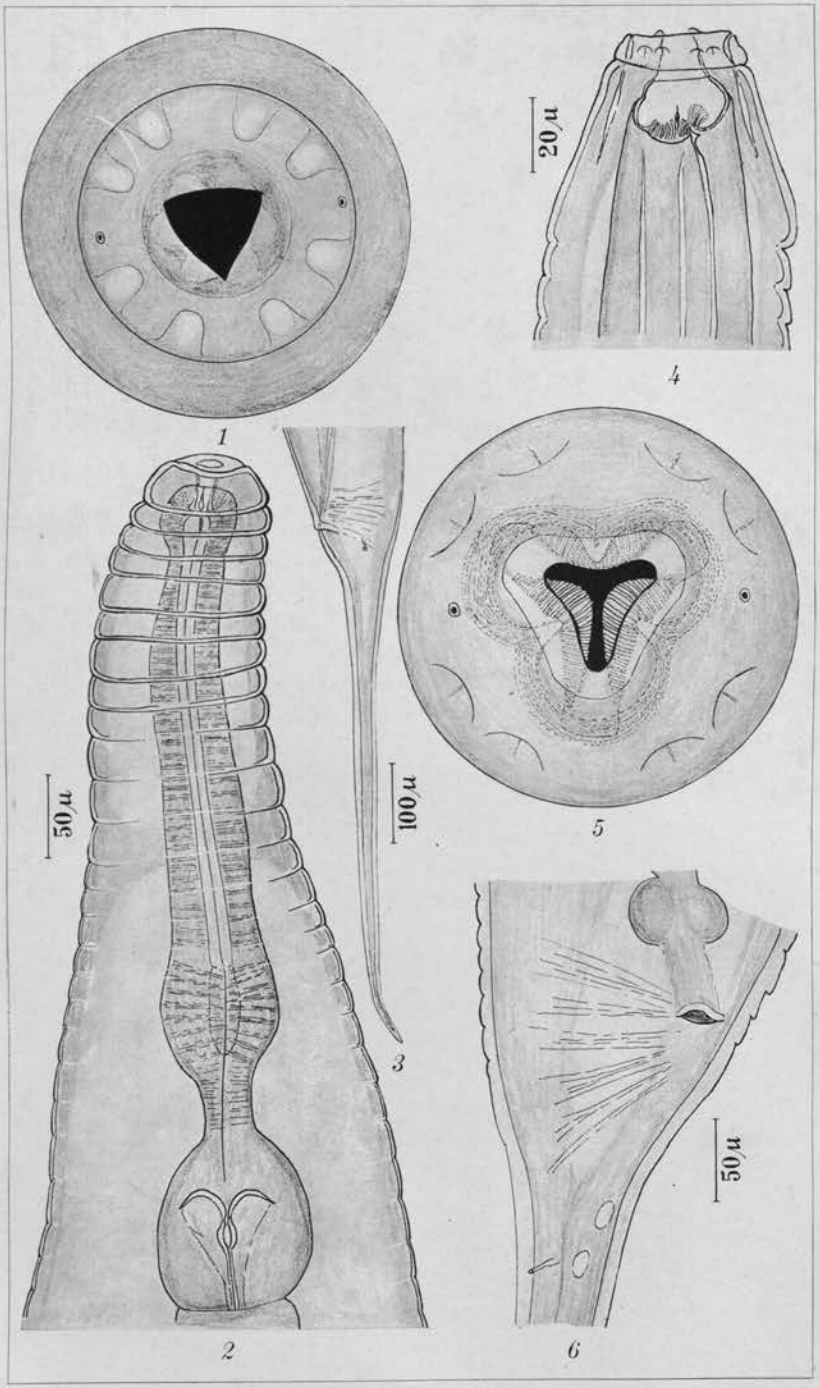
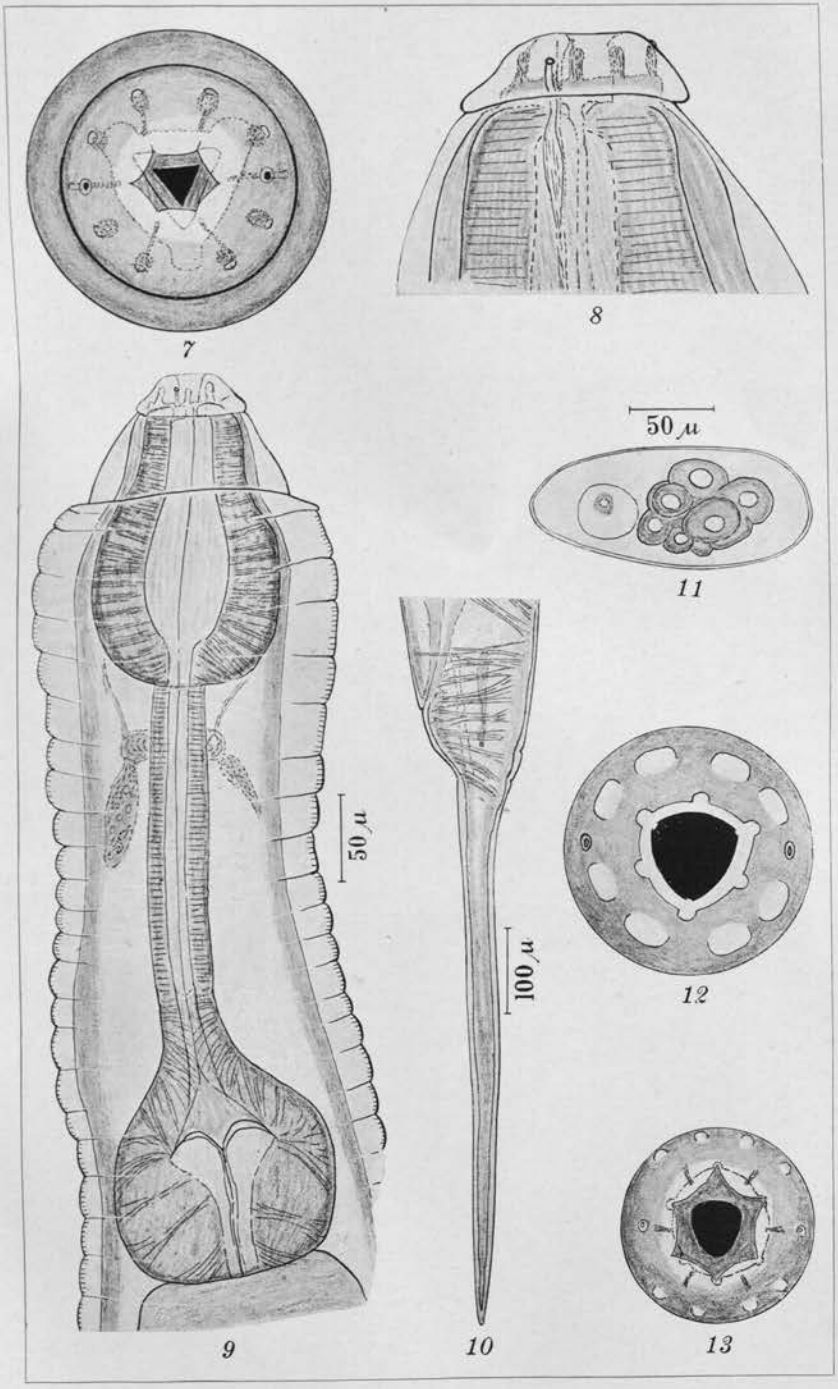


PLATE 1.



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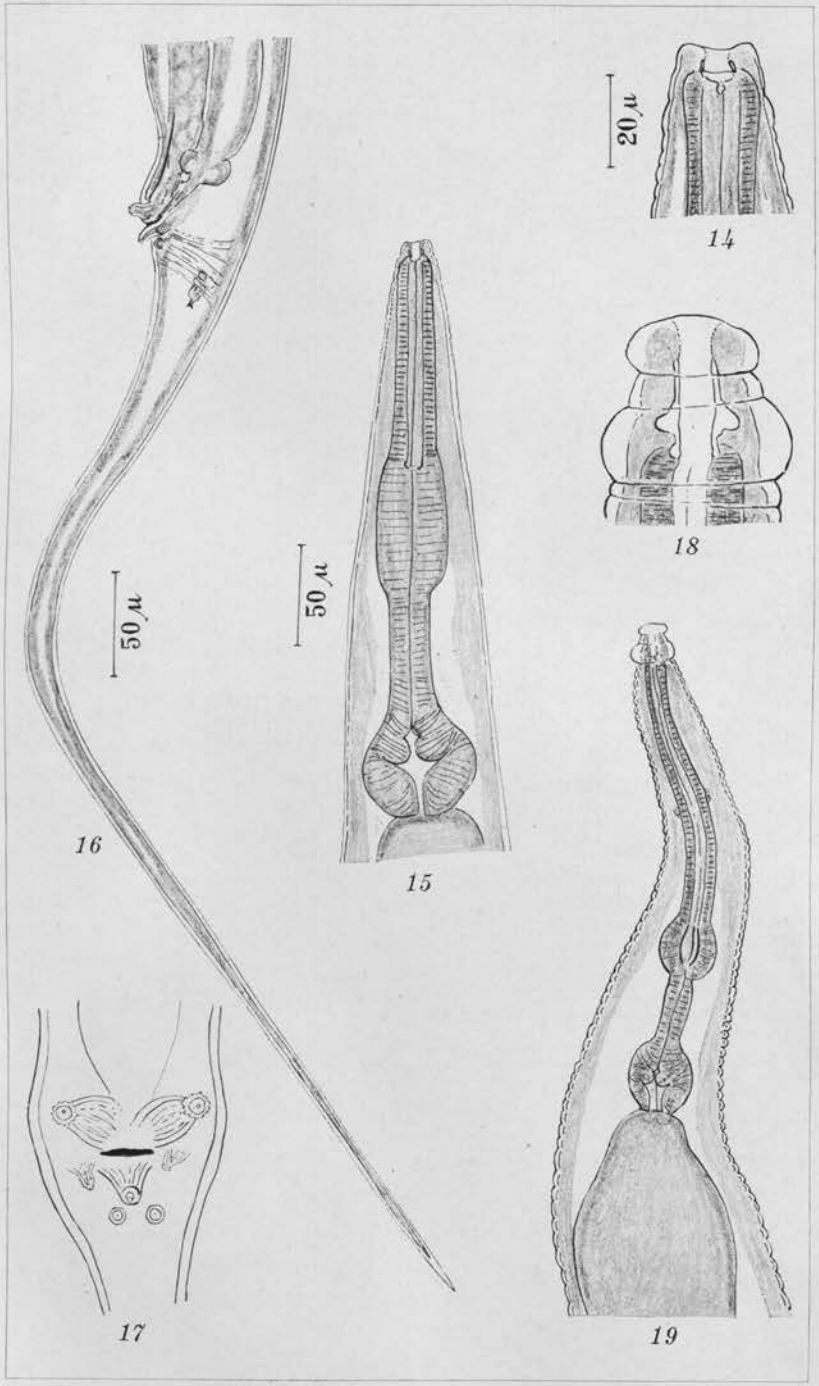

PLATE 3.

NEW OR LITTLE-KNOWN TIPULIDÆ FROM EASTERN ASIA (DIPTERA), XVII [1]

By CHARLES P. ALEXANDER

Of Amherst, Massachusetts

FIVE PLATES

The Tipulidæ discussed at this time were included in extensive series of specimens from eastern Siberia, sent to me for determination by Dr. Theodore Pleske and Dr. A. von Stackelberg, of the Russian Academy of Sciences, Leningrad. In this report, species of the genus *Tipula* are discussed. I express my deep thanks to the entomologists and collectors mentioned in the text for the opportunity of studying this unusually interesting series of crane flies. The types of the novelties are preserved in the Russian Academy of Sciences.

There is, perhaps, no faunal region on earth where a wider acquaintance with species from many other localities is required. In eastern Siberia, in addition to the far more numerous endemic forms, there occur elements derived from three distinct sources, as follows:

1. *From the south.*—Japan and eastern China. Many species hitherto reported only from Japan are now known to range at least as far as the Ussuri, and, in cases, still farther to the north. Representatives of genera, subgenera, and species of tropical affinities reach the Ussuri, including *Pselliophora*, *Libnotes*, *Limonia* (*Rhipidia*) *pulchra* de Meijere, *Paratropesa*, and *Styringomyia*.

2. *From the west.*—Europe and western Asia. Several species of well-known European crane flies reach the Amur country unchanged; these include more especially members of the subfamily Limoniinæ, as *Tipula* (*Tipula*) *czizeki* de Jong, *Limonia* (*Dicranomyia*) *patens* (Lundström), *Pedicia* (*Pedicia*) *arctica* Frey, *Limnophila* (*Limnophila*) *pictipennis* Meigen, *L.* (*Tricholimnophila*) *punctum* Meigen, and others. Still other forms, while allied to European species, show characters deemed to

[1] Contribution from the entomological laboratory, Massachusetts State College.

be of specific worth. In most of the last-named cases, a third vicarious species occupies boreal North America, so the various members are about equidistantly spaced throughout the boreal and subboreal portions of the Northern Hemisphere. Examples of such representative forms chosen from the genus *Tipula* are as follows:

Western Palæarctic (Europe).	Eastern Palæarctic (eastern Siberia).	Northern Nearctic (Canada).
excisa Meigen.	*excisoides* sp. nov.	*balioptera* Loew.
subexcisa Lundström.	*lundströmiana* sp. nov.	*serta* Loew.
	dershavini sp. nov.	*senega* Alexander.
vafra Riedel.	*cupida* sp. nov.	*fragilina* Alexander.
luteipennis Meigen.	*mediolobata* sp. nov.	
quadrivittata Staeger.	*subsulphurea* Alexander.	*sulphurea* Doane.

Certain genera and subgenera, as *Acutipula* Alexander, *Thaumastoptera* Mik, *Limnophila* Meigen, sensu strictu, and *Tricholimnophila* Alexander, occupy the entire northern Palæarctic Region but apparently have not reached the American continent.

3. *From the east.*—Alaska and the Canadian northwest. A growing list of species falls in this category, including *Tipula macrolabis* Loew, *Limonia* (*Discobola*) *argus* (Say), *L.* (*D.*) *platyrostra* Alexander, and *Limnophila unica* Osten Sacken. In Asia such species occur in Kamchatka and southward and have evidently been distributed via the Aleutian and Commodore Islands, rather than to the northward across the narrower Bering Strait.

In addition to all the above, there is found a considerable number of very widespread forms that range throughout the entire Holarctic Region, including hardy representatives of *Limonia, Helobia, Trimicra,* and other genera.

TIPULINÆ

Genus TIPULA Linnæus

Tipula Linnæus, Systema Naturæ, ed. 10 (1758) 585.

Subgenus VESTIPLEX Bezzi

Tipula (*Vestiplex*) Bezzi, Ann. Mus. Civ. Stor. Nat. Genova 51 (1924) 230–231.

Tipula (*Vestiplex*) Edwards, Ann. & Mag. Nat. Hist. X 8 (1931) 79–80.

Numerous species of *Vestiplex* are found throughout the Holarctic Region. The characters of the group have been recast by Edwards in the paper cited above, and it is my purpose here

only to note a few additional points concerning the details of structure of the male hypopygium.

The caudal portion of the ninth tergite is often, if not usually, heavily sclerotized and blackened, forming a more or less distinct shallowly depressed area with narrow raised rims that is herein discussed as the "tergal saucer." Behind this saucer, less heavily thickened portions of the tergite occur, the median line being almost invariably more membranous. In a number of species of *Vestiplex,* the tergal saucer tends to swing ventrad so as to lie on the lower face of the tergite, in which case the only part of the sclerite visible from above is the feebly sclerotized cephalic portion, together with the cephalic rim of the saucer, where this is developed. In such cases, when treated with caustic soda, the saucer swings dorsad and cephalad so as to assume its normal position. This curious occurrence was first noted by Mr. Edwards, and unless appreciated may cause confusion in the separation of allied species. In most species of *Vestiplex,* the blackened tergal saucer occupies the caudal half or more of the tergite; in a few species, as *tchukchi* sp. nov., the saucer is so extensive that it embraces the entire mid-dorsal area of the tergite. In other forms, the saucer is pale yellow, only feebly sclerotized, and is delimited behind only by the variously modified mid-cephalic rim of the plate (as in *immunda* sp. nov., *pallitergata* sp. nov.). Both cephalic and caudal rims of the saucer may bear major teeth or denticles, the size of which is best judged when viewed laterally. In the *excisa* group, the mid-caudal region of the plate bears a stout median spine (*excisoides* sp. nov., *kamchatkana* sp. nov.).

The basistyle is sometimes simple but more often its caudal margin is produced into a conspicuous spine that may be either pale, tipped with black, or entirely blackened. Such a spine is found in the four commonest European species (*excisa* Schummel, *nervosa* Meigen, *rubripes* Schummel, and *scripta* Meigen) but is lacking in *sintenisi* Lackschewitz. The species of *Vestiplex* in eastern Siberia fall in the following groups based on this feature of the basistyle:

1. Basistyle unarmed; *arctica* Curtis, *kuwayamai* Alexander, *subcentralis* Alexander, *tchukchi* sp. nov., *transbaikalica* sp. nov.

2. Basistyle with an elongate acute spine; *excisoides* sp. nov., *immunda* sp. nov., *kamchatkana* sp. nov., *pallitergata* sp. nov.

3. Basistyle with spine expanded at tip to appear more or less bifid; *coquillettiana* Alexander.

The male of *Tipula jakut* Alexander is unknown. Whether the true *arctica* occurs in eastern Siberia is somewhat questionable to me, although it is definitely known from Taimyrland (reported in letter by Lackschewitz). The species falls in the group with unarmed basistyle and may be told by the dark body coloration, unusually marked nodulose antennæ of the male sex, and the simple structure of the inner dististyle of the male hypopygium.

TIPULA (VESTIPLEX) EXCISOIDES sp. nov. Plate 1, fig. 1; Plate 2, figs. 25, 26.

Allied to *excisa;* nasus short and stout, or lacking; antennæ (male) with the flagellar segments strongly incised, the first flagellar segment pale; terminal flagellar segment elongate; mesonotal præscutum gray, with four darker gray stripes that are narrowly bordered by brown; wings pale brown, variegated by darker brown and whitish areas; abdomen chiefly reddish brown, the outer segments darkened; male hypopygium with the tergal saucer bearing an acute median spine on caudal border.

Male.—Length, 16 to 17 millimeters; wing, 15 to 16; antenna, about 5.

Female.—Length, 25 millimeters; wing, 16; abdomen alone, 19.5.

Frontal prolongation of head yellowish brown, sparsely pruinose; nasus short to lacking; palpi brownish black. Antennæ (male) with the basal three segments yellow, the succeeding one or two weakly bicolorous, the remainder almost uniformly brownish black, the basal enlargement being a trifle darker than the remainder; flagellar segments very strongly incised; terminal segment elongate, exceeding one-third the length of the penultimate. In female, antennæ much shorter, chiefly yellow, only the outer segments darkened. Head gray.

Mesonotal præscutum light gray, with four slightly darker gray stripes that are narrowly bordered by dark brown; scutum light gray, the lobes variegated by darker gray; posterior sclerites of notum light gray. Pleura light gray; dorsopleural region buffy. Halteres pale, the knobs dark brown, their extreme tips pale. Legs with the coxæ gray; trochanters yellow; femora yellow, the tips narrowly and gradually infuscated; tibiæ yellowish brown, the tips darkened; tarsi passing into black. Wings (Plate 1, fig. 1) pale brown, the prearcular and costal regions more yellowish; stigma and smaller areas at origin of Rs and on anterior cord brown; whitish areas on disk, including the

bases of the outer radial cells, cell 1st M_2, a conspicuous fenestrate area at two-thirds the length of cell M, and a common mark that includes the base of cell M and subbasal spots in cells Cu and 1st A; veins brown. Venation: R_3 sinuous; m a little shorter than the petiole of cell M_1; M_{3+4} subequal to or shorter than m.

Abdomen chiefly reddish brown, the outer segments darkened; tergites with a very narrow brown sublateral line, more conspicuous on basal segments, the actual borders narrowly pale; abdomen of female moderately long. Male hypopygium with the caudal portion of ninth tergite (Plate 2, fig. 25, 9*t*) appearing as a black polished saucer, much as in *excisa* but with the median caudal horn stout, pointed at apex, and unprovided with setæ; cephalic border of saucer, 9*t*, without, or with but few, raised points or denticles. In *excisa* (Plate 2, fig. 26), the median caudal horn of tergite, 9*t*, is slender, truncated at tip, the sides of the horn with erect black setulæ; cephalic border of saucer with a series of from six to eight elevated blackened points.

Habitat.—Eastern Siberia (Kamchatka).

Holotype, male, Ajan, 137° 30′ east longitude, 56° 40′ north latitude, July 18 to 31, 1912 (*Czerski*), No. 726. Allotype, female, Kamchatka River, 159° east longitude, 56° north latitude, July and August, 1914 (*Bjeloussov*, Hydrographic Expedition to Pacific), No. 558. Paratopotype, 1 male, 1903 (*Popoff*), No. 447. Paratypes, 4 males, with allotype, Nos. 552, 554, 555, 557; 1 male, Petropavlovsk, July 27, 1907 (*Smirnov*), No. 650; 1 male, Petropavlovsk, June 17, 1910 (*Skorikov*), No. 644; 1 male, mouth of Kichiga River, June 27, 1910 (*Skorikov*), No. 648.

The closest relative of the present fly is *Tipula* (*Vestiplex*) *excisa* Schummel, of Europe, which differs in slight structural and colorational details. In *excisa* the flagellum is entirely black, with the terminal flagellar segment small and thimble-like; male hypopygium with the median horn of tergal saucer truncated at apex, the sides with conspicuous, erect, black setulæ. A third member of this restricted group is *T.* (*V.*) *balioptera* Loew, of boreal North America, which differs in the bicolorous antennal flagellum and details of structure of the male hypopygium.[2]

[2] Alexander, Mem. Cornell Univ. Agr. Exp. Sta. 25 (1919) 948, pl. 46, fig. 227 (wing); pl. 50, fig. 279 (ninth tergite); pl. 54, fig. 337 (lateral aspect of male hypopygium).

TIPULA (VESTIPLEX) KAMCHATKANA sp. nov. Plate 1, fig. 2; Plate 2, fig. 27.

Allied to *excisa;* general coloration of body black, heavily gray pruinose; antennæ (male) with flagellar segments strongly incised; entire antennæ black, excepting the reddish pedicel; præscutum gray, with four slightly darker stripes and a very conspicuous brownish black median præscutal vitta; tips of femora broadly blackened, most extensively so on forelegs; wing pattern very diffuse.

Male.—Length, 14 to 16 millimeters; wing, 14 to 15; antenna, 4.3 to 4.5.

Female.—Length, 12 to 14 millimeters; wing, 12 to 13.

Frontal prolongation of head black, heavily pruinose; nasus distinct; palpi black. Antennæ black, only the pedicel obscure reddish; scape pruinose; in cases the pedicel is black, like the remainder of organ; flagellar segments strongly incised; verticils short and powerful, shorter than the segments; terminal segment about two-fifths the penultimate. Head dark gray, with indications of a blackish median stripe.

Mesonotum gray, the præscutum with four poorly defined grayish brown stripes that are very narrowly bordered by brown, the latter sometimes obsolete, especially on the cephalic portions of the sclerite; a very distinct, dull brownish black, median, præscutal stripe; posterior sclerites of mesonotum blackish, gray pruinose. Pleura gray pruinose; dorsopleural region obscure buffy. Halteres infuscated, the knobs strongly so. Legs with the coxæ gray; trochanters yellow; femora obscure yellow basally, the tips broadly blackened, most extensively so on the forelegs, where nearly the outer three-fifths are darkened, on the posterior femora with more than the outer third blackened; tibiæ and tarsi brown, the latter passing into black. Wings (Plate 1, fig. 2) with a very pale brown tinge, the prearcular and costal regions brighter yellow; stigma pale brown, confluent with similar vague areas on anterior cord; ill-defined whitish areas beyond stigma, across cell 1st M_2 and near outer end of cell M; veins brown, brighter in the flavous areas. Venation: Cell M_1 variable, from about one-half longer than its petiole to twice as long as petiole.

Abdomen black, dark gray pruinose; lateral borders of tergites pale, the caudal margins very narrowly so. Male hypopygium much as in *excisoides;* tergal plate (Plate 2, fig. 27, 9*t*) relatively small, the lateral lobes broadly truncated; median-

caudal spine stout; posterior border of saucer with about six blackened denticles. Basistyle and dististyles much as in *excisoides*.

Female generally as in the male; fully winged.

Habitat.—Eastern Siberia (Kamchatka).

Holotype, male, Alpine zone of the Shiveluch Range, 162° 30′ east longitude, 56° 40′ north latitude, June 25, 1909 (*Dershavin*), No. 399. Allotype, a broken female, Shiveluch Volcano, near Nischnekamchatsk, June 26, 1909 (*Schmidt*), No. 331. Paratopotypes, 3 males, Nos. 395, 397, 398; 1 broken female, No. 396. Paratypes, 1 male, Volcano Kluchevskoje, Kyrgurich, altitude 3,000 to 4,000 feet, June 12, 1909 (*Dershavin*), No. 393; 7 males and females, with the allotype, Nos. 327, 329–330, 332–335, inclusive; 1 male, Kluchevskoje Village, June 10, 1909 (*Dershavin*), No. 357; 1 male, Ust-Kamchatsk, near Nischnekamchatsk, July 17, 1909 (*Dershavin*), No. 348; 1 broken male, Alpine zone of Solocha River, Volcano Kluchevskoje, June 13, 1909 (*Dershavin*), No. 403; 1 female, Krutenkaja River, June 22, 1909 (*Koslovsky*), No. 422. These materials were collected on the Rjabushinsky Brothers Expedition, 1909.

Tipula (*Vestiplex*) *kamchatkana* is allied to *excisa* Schummel, *excisoides* sp. nov., and *balioptera* Loew. It is well distinguished by the black antennæ, with only the pedicel obscure reddish, the conspicuous median præscutal stripe, the extensively blackened fore femora, and other features. The general coloration of the entire body is black, heavily pruinose with gray.

TIPULA (VESTIPLEX) PALLITERGATA sp. nov. Plate 1, fig. 3; Plate 2, fig. 28.

General coloration light gray, the præscutum with four darker gray stripes that are conspicuously bordered by brown; antennæ (male) elongate, nearly one-half the length of body; femora obscure yellow, the tips blackened, more extensively so on forelegs; wings with the pattern pale and diffuse, chiefly pale brown and white; male hypopygium with the tergal plate light yellow, including the saucerlike posterior portion; at near center of disk a small transverse elevation bearing two blackened points; spine of basistyle straight, pale, the narrow acute tip blackened.

Male.—Length, 14 to 15 millimeters; wing, 15 to 15.5; antenna, 6.5 to 7.5.

Frontal prolongation of head gray; nasus long and conspicuous; palpi black. Antennæ (male) unusually long for a mem-

ber of this subgenus, only a little less than one-half the length of the body; scape dark, pruinose; pedicel obscure yellow; succeeding segments very weakly bicolorous, dark brown, the basal enlargements black; segments beyond the fifth passing into uniform black; in the paratype the antennæ are much more extensively bicolorous; flagellar segments strongly incised; verticils shorter than the segments; terminal segment about one-third the length of penultimate. Head gray, the vertex with a broad, conspicuous brown line.

Mesonotal præscutum light gray, with four darker gray stripes that are conspicuously bordered by brown, especially on their cephalic portions; intermediate stripes broad in front, narrowed behind, contiguous at ends but widely separated at midlength, the brown margins suffusing the outer ends of stripes; lateral stripes without dark markings along most of their mesal edge; posterior sclerites of notum light gray, the scutal lobes variegated with dark gray, of which the more cephalic area is narrowly ringed with brown; scutellum with a more or less distinct median brown line. Pleura gray; dorsopleural region buffy. Halteres long, pale yellow, the knobs dark brown. Legs with the coxæ pale gray; trochanters obscure yellow; femora obscure yellow, the tips blackened, more extensively so on forelegs where approximately the outer third or more is darkened, very narrowly blackened on the other legs, tibiæ brown, the tips passing into black; tarsi black. Wings (Plate 1, fig. 3) with the ground color very pale brown; prearcular and costal regions light yellow; very extensive whitish areas over most of wing disk, greatly restricting the ground color; slightly darker brown clouds at origin of Rs and on anterior cord; veins brown, yellow in the flavous areas. Venation: M_{3+4} variable, being longer or shorter than the petiole of cell M_1.

Abdominal tergites reddish brown, narrowly trivittate with brown, the median stripe broader and nearly continuous; sublateral stripes very narrowly interrupted; lateral margins gray; outer segments brown, heavily pruinose, the caudal margins narrowly pale. Male hypopygium brownish yellow, the tergal plate pale, not polished black as in other regional members of the subgenus. Hypopygium with the tergal plate (Plate 2, fig. 28, 9*t*) pale yellow, including the outer saucer; caudal margin with a broad U-shaped notch, at the base of which is a tiny rounded notch; cephalic portion of saucer with an elevated, blackened,

transverse ridge that is set with a blackened point on either side of midline. Basistyle, *b*, with an elongate straight spine, pale except for the short, gently curved apex. Outer dististyle, *od*, pale, slightly flattened. Inner dististyle, *id*, broad, bifid at apex, the outer spine acute.

Habitat.—Eastern Siberia (Ussuri).

Holotype, male, Vladivostok, May 29, 1927 (*Stackelberg*), No. 229. Paratype, male, Maiche region, near Shkotovo, June 4, 1927 (*Sokolov*), No. 579.

The pale yellow ninth tergite of the male hypopygium readily separates this fly from all other regional allied forms. In this respect it suggests the eastern Nearctic *Tipula* (*Vestiplex*) *caroliniana* Alexander and *T.* (*V.*) *longiventris* Loew, which are otherwise quite different flies. The antennæ of the male of the present fly are of an unusual length for a member of this subgenus.

TIPULA (VESTIPLEX) IMMUNDA sp. nov. Plate 1, fig. 4; Plate 2, fig. 29.

General coloration light gray, the præscutum with four slightly darker gray stripes that are narrowly bordered by brown; antennæ (male) relatively short; wings with bases of cells R and M narrowly darkened; male hypopygium with the tergal plate pale, the cephalic rim appearing as an elevated quadrate plate, its margin narrowly blackened; basistyle produced into a strong pale spine.

Male.—Length, about 15 millimeters; wing, 16.5; antenna, about 3.

Frontal prolongation of head brownish gray; nasus stout; palpi black. Antennæ (male) unusually short for a member of this subgenus; basal three segments yellow; succeeding segments bicolorous, the basal enlargement darker than the apices; outer segments more uniformly darkened; flagellar segments weakly incised; verticils subequal to or slightly longer than the segments; terminal segment about one-third the penultimate. Head gray; a vague capillary blackish line on vertex; setigerous punctures black, conspicuous.

Mesonotal præscutum light gray, with four slightly darker gray stripes that are narrowly but conspicuously bordered by brown; intermediate stripes a little bowed beyond midlength to expose a linear strip of the ground; scutum light gray, each lobe with two darker gray areas that are very insensibly bordered by brownish, this being especially apparent along the cephalic

borders; posterior sclerites of mesonotum light gray, the mediotergite with a narrow median dusky vitta. Pleura with the mesepisternum gray, the posterior sclerites more whitish gray. Halteres pale, the knobs infuscated. Legs with the coxæ light gray; trochanters yellow; femora obscure yellow, the tips narrowly blackened; tibiæ brownish yellow, the tips narrowly darkened; tarsi passing into black. Wings (Plate 1, fig. 4) with the ground color brown, variegated by darker brown and whitish, the pattern more diffuse than usual; a dark post-arcular area in bases of cells R and M; veins brown. Macrotrichia relatively abundant on veins beyond cord; R_{1+2} glabrous on outer half; vein 1st A entirely without trichia; vein 2d A with numerous trichia on more than distal half. Venation: Cell 1st M_2 elongate, with m-cu just before midlength of lower face.

Abdominal tergites dark reddish yellow, with a narrow, interrupted blackish median stripe; sublateral dark stripes almost obsolete; basal sternites yellow; outer abdominal segments more uniformly darkened. Male hypopygium (Plate 2, fig. 29) with the tergal plate, 9*t*, very different from the other regional members of the subgenus. The main body of the tergal saucer is pale, with the caudal margin broadly emarginate, the cephalic border appearing as an elevated quadrate plate whose margin is narrowly blackened; in a position of rest, the pale portion of the saucer is deflected ventrad so the elevated cephalic plate forms what appears to be the extreme caudal edge of the tergite, in this case being directed caudad instead of the normal position of cephalodorsad; caudal lobes of tergite pale with long pale setæ. Basistyle, *b*, with a strong spine, pale in color, the extreme tip acute and blackened. Outer dististyle, *od*, flattened. Inner dististyle, *id*, broad, the outer margin at near two-thirds the length with a sharp spine.

Habitat.—Eastern Siberia (Saghalien).

Holotype, male, Nodeskda Bay, July 9, 1908 (*Soldatov*), No. 682.

In its pale ninth tergite of the male hypopygium, with no blackened armature excepting a glabrous plate at cephalic end of saucer, the present fly is closest to *Tipula* (*Vestiplex*) *pallitergata* sp. nov., differing especially in the short antennæ of the male and in the details of structure of the hypopygium. The nature of the tergal saucer is different from that of any other Old World species known to me.

TIPULA (VESTIPLEX) COQUILLETTIANA Alexander.

Tipula coquillettiana ALEXANDER, Philip. Journ. Sci. 24 (1924) 605–606; Encycl. Entomolog., Diptera 2 (1925) 91–92, figs. 6–8 (details of male hypopygium).

The types, two males, were collected at Odasam, southern Saghalien, in August by Prof. Teiso Esaki. A further male was later taken in Hokkaido, Japan, in August, by Mr. Tamanuki.

A further series of specimens from eastern Siberia seem surely referable to this species, despite certain slight differences in coloration and structure. The subapterous female is described below as allotype.

Allotype.—Female, length, about 30 millimeters; wing, 5; abdomen alone, 24.

Wings greatly reduced, stenopterous, appearing almost uniformly infuscated. Basal four or five flagellar segments pale, the succeeding segments bicolorous, the outer segments more uniformly darkened. Præscutal stripes poorly indicated against the gray ground color. Abdomen long, chiefly gray, the tergites obscure reddish on either side of midline. Ovipositor with tergal shield and cerci polished brownish black. Hypovalvæ terminating in slender, hairlike points.

Allotype, female, Nikolajevsk, Amur River, July 21, 1915 (*Chernavin*), No. 701.

Other records: A female, Chhil region, Amur River, Ussuri, July 28, 1908 (*Soldatov*), No. 660; a female, Selenyi border, Ussuri, 600 kilometers from Habarovsk, 1908 (*Soldatov*), No. 681; males and females, Osernaja, mouth of the Amur, June 10 to 13, 1915 (*Chernavin*), Nos. 705, 708, 712; a female, Okonen River, Amur, June 21 to 23, 1914 (*Dorogostaiski*), No. 599; a female, with the allotype, No. 704.

It is possible that more than a single species is confused in the above series, since the antennal flagella vary in color from brownish black to bicolorous, but in the absence of sufficient males, I am unable to separate the flies.

TIPULA (VESTIPLEX) KUWAYAMAI Alexander.

Tipula kuwayamai ALEXANDER, Ann. Ent. Soc. Am. 14 (1921) 130–131; Encycl. Entomolog., Diptera 2 (1925) 93.

Described from Sapporo, Hokkaido, Japan; collected in June by Prof. Satoru Kuwayama. Later (Alexander, 1925) reported from the Ussuri. A considerable series of additional specimens are available.

Golden Horn, Vladivostok, May 25 to June 1, 1911 (*Rydzevski and Kuznetzov*), Nos. 427 to 429; Sedanka, near Vladivostok, June 20, 1927 (*Stackelberg*), No. 248; Okeanskaja station, June 25, 1926 (*Mordvilko*), No. 614; Tigrovaja, Suchan district, June 3 and 4, 1927 (*Stackelberg*), No. 93; Vinogradovka, May 30 to June 2, 1929 (*Djakonov and Filipjev*), Nos. 548, 549; Maiche region, near Shkotovo, June 7, 1927 (*Sokolov*), Nos. 570, 573; Spassk, June 4, 1928 (*Obolenskij*), No. 589; Kamen-Rybolov, Lake Chanka, May 24 and 25, 1908 (*Czerski*), No. 301; Seja River, Amur Province, June 27 to 29 (*Rittig*), No. 639; Saghalien Island, August 9 to 22, 1906 (*Smirnov*), No. 649; Pilva, Saghalien, June 27, 1910 (*Derbeck*), No. 319.

Many of the specimens, especially the males, average somewhat larger than the types (male, length, 19 to 20 millimeters; wing, 21 to 23; female, length, 28 to 31 millimeters; wing, 24 to 25). In some specimens, all four præscutal stripes are clear light gray, bordered by brown; in certain other cases, the intermediate stripes are more suffused with brown, especially on their posterior portions, the broad lateral stripes remaining clear light gray, contrasting strongly with the intermediate pair. In some other specimens, the interspaces likewise become suffused with light brown.

TIPULA (VESTIPLEX) TRANSBAIKALICA sp. nov. Plate 1, fig. 5; Plate 2, fig. 30.

General coloration of head and thorax gray, the præscutal stripes scarcely differentiated from the ground; antennæ with basal flagellar segments bicolorous; knobs of halteres yellow; wings pale brown, with a weak darker brown and white pattern; abdomen obscure yellow, the subterminal segments darker; male hypopygium with a conspicuous, polished, black tergal saucer, the caudal rim notched medially, the lateral lobes obliquely truncated and coarsely toothed; no caudal production of basistyle; outer dististyle flattened-oval; inner dististyle unusually short, bifid at apex.

Male.—Length, about 18 millimeters; wing, 19; antenna, about 3.8.

Frontal prolongation of head reddish brown; nasus short and stout; palpi obscure brownish yellow, the outer segment darkened at outer end. Antennæ with scape and pedicel obscure yellow; basal flagellar segments bicolorous, the basal enlargement dark brown, the stem yellow; fifth and succeeding flagellar segments more uniformly darkened; terminal segment slightly exceeding one-half the length of the penultimate. Head dark gray.

Pronotum brownish gray. Mesonotal præscutum almost uniformly dark gray, the usual stripes scarcely differentiated from the ground; posterior sclerites of mesonotum gray, the scutellum more brownish. Pleura extensively brownish gray, the posterior sclerites, especially the pleurotergite, more yellowish; dorsopleural membrane buffy. Halteres pale, the knobs light yellow. Legs with the coxæ light gray pruinose, the apices paling to yellowish; trochanters yellow; femora yellow, the tips narrowly dark brown; tibiæ reddish brown, the tips darkened; tarsi brownish black. Wings (Plate 1, fig. 5) with the ground color very pale brownish, the prearcular and costal regions light yellow; stigma brown; much reduced brown clouds at origin of Rs and on anterior cord; whitish hyaline areas as follows: An incomplete cross band beyond cord, occupying parts of cells Sc_2, R_2, and R_3, separated from an obliterative area across cell 1st M_2 by a darkened seam along vein M_{1+2}; an ill-defined white area in cell M beneath origin of Rs; veins brown, obliterative areas extensive. Venation: R_{1+2} entire, the distal half glabrous; petiole of cell M_1 about twice the length of m; M_{3+4} about three-fourths the basal section of M_3; m-cu on M_4 just beyond base.

Abdomen obscure yellow basally, the mid-line of basal tergites with a narrow to scarcely evident broken brown line; subterminal abdominal segments darkened. Male hypopygium (Plate 2, fig. 30) with the basistyle large, chiefly separated from the sternite by extensive dorsal and ventral sutures, the intermediate fourth or thereabouts fused. Ninth tergite, *9t*, with the caudal portion a conspicuous blackened saucer, relatively small, the caudal margin with a U-shaped median notch, the lobes obliquely truncated, with several coarse teeth that alternate with long setæ; cephalic margin of saucer elevated, each half with two teeth, the lateral pair larger. Basistyle without armature. Outer dististyle, *od*, a flattened oval blade, with numerous pale setæ. Inner dististyle, *id*, unusually short, less than the outer style, bifid at apex.

Habitat.—Eastern Siberia (Transbaikal).

Holotype, male, Borochojeva (ex Staudinger-Bang Haas); type in author's collection.

Among the regional species, *Tipula* (*Vestiplex*) *transbaikalica* is most nearly allied to flies such as *T.* (*V.*), *subcentralis* Alexander, differing conspicuously in the structure of the male hypopygium. The fly is even more closely related to *T.* (*V.*) *sintenisi* Lackschewitz, of northern Europe, which differs in the black palpi, dusky knobs of halteres, brown-margined præscutal

stripes, and other features; the details of the male hypopygium are very similar in the two species.

TIPULA (VESTIPLEX) SUBCENTRALIS Alexander. Plate 2, fig. 31.

Tipula subcentralis ALEXANDER, Journ. New York Ent. Soc. 26 (1918) 73–74; Encycl. Entomolog., Diptera 2 (1925) 92–93, figs. 9–11 (details of male hypopygium).

The type, and previously only known specimen, is a unique male that was collected in Kamchatka by Leonhard Stejneger.

Two additional specimens present the following data: A male, in teneral condition, Kamchatka River, Kamchatka, 159° east longitude, 56° north latitude, 1898 (*Gondatti*), No. 591. A second male in good condition, valley of Bystraja River, Kamchatka, July 15, 1908 (*Protopov*), No. 419.

The male hypopygium has the tergal saucer with caudal margin subtransverse to very feebly notched, the margin with microscopic denticles, of which a submedian pair is slightly larger; cephalic border of saucer with scanty denticles. Basistyle unarmed. Outer dististyle (Plate 2, fig. 31, *od*) a narrowly flattened pale lobe. Inner dististyle, *id*, terminating in a simple, obtusely rounded apex, with a carina back from tip. The simple inner dististyle is characteristic of the species.

TIPULA (VESTIPLEX) TCHUKCHI sp. nov. Plate 1, fig. 6; Plate 2, figs. 32, 33.

Size small (wing about 12 to 13 millimeters); mesonotum black, with four darker gray stripes; antennæ (male) with flagellar segments strongly incised; basal flagellar segments bicolorous; male hypopygium with the tergal saucer very large, heavily blackened, extended cephalad so as to overlie the eighth tergite, the cephalic border elevated; basistyle unarmed.

Male.—Length, about 11 to 12 millimeters; wing, 12 to 13.2.

Female.—Length, about 16 millimeters; wing, 12.

Frontal prolongation of head dark gray; nasus short and blunt; palpi brownish black. Antennæ (male) of moderate length; scape brownish yellow; pedicel and first flagellar segment obscure yellow; succeeding flagellar segments weakly bicolorous, the basal enlargement black, the outer portion obscure yellow; outer segments more uniformly blackened; flagellar segments rather strongly incised, only a very little less so than in the *excisa* group. Head gray, with a capillary black median vitta extending the whole length of the sclerite.

Mesonotal præscutum black, very thinly pruinose with dark leaden gray to produce four scarcely apparent stripes, the interspaces darker; the paratypes have the pruinosity heavier to

produce four dull gray stripes that are vaguely bordered by brown; posterior sclerites of notum gray. Pleura light gray, the dorsopleural region more buffy. Halteres pale yellow, the knobs weakly darkened. Legs with the coxæ light gray; trochanters yellow; remainder of legs broken. Wings (Plate 1, fig. 6) with the ground color very pale brown, variegated by whitish areas; prearcular and costal regions light yellow; stigma oval, dark brown; the white areas include a nearly complete fascia beyond cord, a large conspicuous spot in outer half of cell M, the bases of cells Cu and 1st A, with other less evident brightenings; veins brown, paler in the white areas. Venation: M_{3+4} subequal to or shorter than basal section of M_3.

Abdomen with basal tergite brownish gray; succeeding tergites yellow, with a very narrow median brown stripe that is narrowly interrupted at caudal margin of the segments; lateral borders of tergites rather narrowly bordered by buffy, delimited internally by a delicate dusky line; outer segments, including hypopygium, uniformly blackened; basal sternites yellow. In the female, the tergites show three broader and more continuous brown stripes that continue caudad to the shield of the ovipositor. Male hypopygium (Plate 2, fig. 32) with the tergal saucer (Plate 2, fig. 33, 9*t*) unusually large and conspicuous, heavily blackened, when viewed from above covering the whole dorsal surface of tergite; posterior border of saucer free and conspicuously elevated, in a position of rest extending back over the caudal border of the eighth tergite, quite concealing the midcephalic region of the ninth tergite; viewed laterally, the saucer bears about four spinous points on either side, the cephalic and caudal ones larger; lobes of caudal border of tergite broadly truncated and provided with microscopic blackened denticles. Basistyle small, entirely unarmed. Outer dististyle, *od*, moderately flattened, dusky in color. Inner dististyle, *id*, flattened, the apex only shallowly bidentate. Ovipositor with the dorsal teeth of cerci subobsolete, the ventral row conspicuous.

Habitat.—Eastern Siberia (Anadyr Region, Kamchatka).

Holotype, male, Markovo, Chuckchiland, Anadyr Gulf, 170° east longitude, 65° north latitude, July 6, 1896 (*Gondatti*), No. 586. Allotopotype, female, No. 585. Paratypes, 2 males, mouth of Kichiga River, Kamchatka, June 27, 1910 (*Skorikov*), Nos. 646, 647.

The specific name is that of an aboriginal tribe inhabiting extreme northeastern Asia. In the unarmed basistyle, the present fly groups with species such as *kuwayamai* Alexander, *sub-*

centralis Alexander, and *transbaikalica* sp. nov., differing from all in the small size, general coloration, and, especially, the very extensive tergal saucer of the male hypopygium.

Subgenus ARCTOTIPULA subgen. nov.

Nasus in most cases relatively short. Body conspicuously hairy, with setæ, on all coxæ and usually on sternopleurite. Tibial spur formula 1–2–2; claws simple. Squama naked; veins beyond cord without macrotrichia or with these much reduced in size and number, most persistent as a loose series on R_{4+5}; in some species, as *gavronskii,* the trichia more abundant. Venation: R_{1+2} entire; cell M_1 usually short-petiolate to sessile, longer in certain species, as *alascænsis;* m-cu lying proximad of to about opposite r-m. Abdomen often depressed. Male hypopygium of simple structure, the tergite separate from sternite. In female, the terminal abdominal segments abruptly narrowed, the ovipositor very small; cerci moderately elongate and only weakly sclerotized, the margins smooth; hypovalvæ small and compressed.

Type of subgenus.—Tipula besselsi Osten Sacken (Arctic America).

Other included species are *T. salicetorum* Siebke (equals *T. nigricornis* Zetterstedt, preoccupied); *T. zetterstedti* Strobl, of northern Europe; *T. alascænsis* Alexander, *T. besselsoides* Alexander, and *T. piliceps* Alexander, of Arctic North America; and four species from eastern Asia, defined as new at this time, *T. gavronskii, T. hirtitergata, T. popoffi,* and *T. tundrensis.*

The chief features of subgeneric importance lie in the unusually glabrous wing veins and the peculiar structure of the ovipositor. As in some other subgeneric groups of *Tipula,* the male sex is more difficult of definition than is the female. The outer medial, cubital, and anal veins either entirely lack macrotrichia or these are greatly reduced. The abruptly narrowed genital segment of the female of most species, with small weak cerci, are likewise distinctive. *Tipula tundrensis* differs from the other included species in having a more glabrous body, the terminal segments of female abdomen not conspicuously narrowed, and the valves of the ovipositor approaching the type found in *Vestiplex,* though with smooth-margined cerci. The species further shows the caudal margin of the eighth sternite of the male hypopygium to be armed with setæ and hair pencils, characters that again are foreign to both *Arctotipula* and

Vestiplex. Riedel [3] records *besselsi* Osten Sacken from the Polar Ural region, but I must regard this identification as being very doubtful.

TIPULA (ARCTOTIPULA) HIRTITERGATA sp. nov. Plate 1, fig. 7; Plate 3, fig. 34.

General coloration brownish gray, the præscutum with four brown stripes; wings grayish subhyaline, stigma brown; no veins with obliterative sections; cell M_1 petiolate; abdomen obscure yellow, the tergites with a median brown longitudinal stripe that is narrowly interrupted at the caudal portion of the segments; ninth tergite of male hypopygium with very abundant black setæ that cover the entire outer portion of disk, the caudal margin with a deep U-shaped notch.

Male.—Length, about 16 millimeters; wing, 17; antenna, about 4.

Frontal prolongation of head relatively short and stout, buffy brown; nasus long and slender; palpi light brown. Antennæ with scape and pedicel brownish yellow; flagellum dark brown; flagellar segments relatively short, feebly incised, with basal verticils only, the longest of these subequal to segment; terminal segment thimble-shaped. Head gray; eyes relatively small; genæ prominent.

Mesonotal præscutum brownish gray, with four brown stripes, the intermediate pair separated only by a capillary line of the ground; lateral margins of præscutum, and especially the humeral regions, clearer gray; interspaces with appressed white setæ; scutum brownish gray, the lobes with slightly darker brown stripes; scutellum pale brown, mediotergite gray; a vague capillary median brown vitta extends from the præscutum to abdomen. Pleura light gray; dorsopleural membrane more buffy. Halteres buffy yellow throughout. Legs with the coxæ light gray, with conspicuous white setæ; trochanters yellow; femora obscure yellow, the tips weakly darkened; tibiæ and tarsi more infuscated. Wings (Plate 1, fig. 7) grayish subhyaline; stigma brown; veins pale brown, without obliterative areas. Macrotrichia relatively abundant but small, on veins beyond cord including an almost complete series on R_3, R_{2+3}, outer section of R_{4+5}, and a weak series of about a score of trichia on M_1; a few trichia near outer end of vein M; other trichia on Cu_1 on either side of level of m-cu; a series on distal third of 2d A; other veins behind R_1 chiefly destitute of trichia. Venation:

[3] Mem. Acad. Sci. Russ. VIII 28, No. 8 (1919) 8.

R_{1+2} entire; petiole of cell M_1 about one-half m; M_{3+4} short, about one-third m; m-cu on M_4 shortly beyond origin.

Abdomen depressed, obscure yellow, the tergites with a conspicuous median longitudinal stripe that is narrowly interrupted at caudal margin of each segment, the areas of the individual segments being narrowed to a point behind; lateral borders of tergites paling to whitish; sternites uniformly yellowish white; pleural membrane darkened. Male hypopygium of unusually simple structure; tergite separate from sternite; basistyle and sternite fused. Ninth tergite (Plate 3, fig. 34, 9*t*) with a very deep U-shaped median notch, the lateral lobes relatively slender, grading to the lateral shoulders; outer half of tergite darkened but not heavily sclerotized, the surface of this portion with abundant coarse black setæ, those of the sides longer and more whitish; posterior half of tergite with sparse setæ; lobes of tergite fringed with delicate pale setulæ. Outer dististyle, *od*, broadly flattened, entirely pale. Inner dististyle, *id*, with a conspicuous, slightly curved black spine on outer margin at near two-thirds the length, the apical portion leaflike; a small group of peglike spines in axis of outer spine. Ninth sternite without lobes. Eighth sternite unarmed.

Habitat.—Eastern Siberia (Amur).

Holotype, male, Dulysmar River, June 5, 1914 (*Dorogostaiski*), No. 601.

Tipula (*Arctotipula*) *hirtitergata* is quite distinct from the other regional species of the subgenus in the petiolate cell M_1 and uniform coloration of wings, the latter without evident obliterative areas.

TIPULA (ARCTOTIPULA) GAVRONSKII sp. nov. Plate 1, fig. 8; Plate 3, fig. 35.

General coloration gray, the præscutum with four darker stripes, the intermediate pair pale, narrowly margined with blackish, the lateral stripes solidly darkened; antennæ with the seven basal segments yellow; wings with a strong brown tinge, only slightly variegated by darker and pale areas; cell M_1 sessile; numerous macrotrichia on veins M_1 and M_2; abdomen depressed, obscure yellow; both the tergites and sternites with an interrupted brownish black median stripe; ovipositor abruptly narrowed; cerci weak and pale.

Female.—Length, about 17 millimeters; wing, 17.

Frontal prolongation of head relatively short and stout, yellowish brown, more pruinose above; nasus powerful; palpi

brown. Antennæ with the basal seven segments yellow, the smaller outer segments darker; basal enlargements of segments scarcely developed; verticils exceeding the segments; terminal segment nearly as long as penultimate. Head gray, with a conspicuous dusky median line.

Mesothorax massive. Mesonotum gray, the præscutum with four darker stripes, the intermediate pair dark gray, narrowly bordered by blackish, the lateral borders beginning at about one-fourth the length of the sclerite, narrowed behind, ending just before the suture; median dark vitta, representing the common internal border of the intermediate stripes extending the entire length of præscutum; lateral stripes relatively narrow but uniformly blackened; humeral region and lateral border of præscutum before suture infuscated; scutum gray, each lobe variegated with blackish areas; scutellum dark gray, brownish black medially, the parascutella pale; mediotergite gray, with a conspicuous dark median line. Pleura buffy, variegated with gray on anepisternum, sternopleurite, and meron; sternopleurite glabrous. Halteres yellow, the knobs dark brown. Legs with the coxæ brownish gray; trochanters yellow; femora yellow, the tips narrowly but very conspicuously blackened; tibiæ yellow, the tips blackened, the degree approximately twice the femoral darkening; tarsi brown; tibial spurs sinuous; claws (female) simple. Wings (Plate 1, fig. 8) with a strong brown tinge, the stigma darker brown; obliterative areas before stigma and across cell 1st M_2; veins brown. Macrotrichia numerous on veins beyond cord, including both M_1 and M_2, becoming more sparse on M_3. Venation: R_{1+2} entire; cell M_1 sessile; m-cu at fork of M_{3+4}, opposite r-m.

Abdomen depressed; basal six tergites obscure yellow, with a very conspicuous, nearly continuous, brownish black, median stripe, this very narrowly interrupted at the extreme caudal margins of segments; terminal segments uniformly dark brown; much paler brown sublateral stripes on tergites; lateral borders pale; sternites yellow, segments two to five, inclusive, with a clearly defined broken black median stripe. Abdominal segments (Plate 3, fig. 35, *o*) beyond the eighth abruptly narrowed; cerci pale, weakly developed, wider at base, narrowed beyond mid-length; basal portion of cerci with pale delicate setulæ.

Habitat.—Eastern Siberia (Ussuri).

Holotype, female, Vladivostok, August 10, 1903 (*Gavronsky*), No. 499.

Tipula (*Arctotipula*) *gavronskii* is named in honor of the collector, who has collected numerous Tipulidæ near Vladivostok. The species is readily told from the other members of the subgenus by the strongly infumed wings, with an unusual number of macrotrichia on the outer medial veins and with cell M_1 sessile. The most similar member of the subgenus is *T.* (*A.*) *popoffi* sp. nov. Attention should be called to the superficially similar *Tipula moiwana* (Matsumura), which is associated with the present fly in collections, but is a typical member of the genus, with normally developed cerci.

TIPULA (ARCTOTIPULA) POPOFFI sp. nov. Plate 1, fig. 9; Plate 3, fig. 36.

Mesonotal præscutum light gray, with four darker gray stripes; antennal flagellum black; femora yellow, the tips narrowly infuscated; wings yellowish gray; stigma brown; wing disk scarcely variegated; macrotrichia of veins beyond cord almost lacking; cell M_1 sessile or nearly so; abdominal tergites yellow, trilineate with dark brown, the lateral borders whitish; sternites clear light gray, the caudal borders yellow.

Female.—Length, about 17 millimeters; wing, 18.5; antenna, about 3.3.

Frontal prolongation of head gray, with long yellow setæ; nasus very short and broad; palpi black. Antennæ with the scape and pedicel brownish yellow; flagellum black; verticils of flagellum exceeding the segments. Head brownish gray, somewhat clearer gray on front and along orbits.

Pronotum light gray, darker medially. Mesothorax broad and massive, the præscutum light gray with four darker brownish gray stripes, the intermediate pair only narrowly separated; interspaces with short yellow setæ; posterior sclerites of thorax gray, the scutellum and mediotergite with indications of a darker median line. Pleura gray, the dorsopleural region buffy; mesopleura glabrous. Halteres yellow, the knobs infuscated. Legs with the coxæ gray, with conspicuous white setæ; trochanters yellow; femora yellow, the tips narrowly infuscated, the amount subequal on all legs; tibiæ brownish yellow; tarsi pale brown. Wings (Plate 1, fig. 9) with a yellowish gray tinge; stigma brown; obliterative areas restricted; vague cream-colored brightenings before and beyond stigma; veins brown. Macrotrichia of veins beyond cord very sparse to virtually lacking, those on vein R_{4+5} being restricted to a series of about a dozen and very small. Venation: R_{1+2} nearly straight, diverging strongly from R_3; cell M_1 very short-petiolate to sessile; M_{3+4} about one-third the basal section of M_3.

Abdomen stout, the tergites conspicuously trilineate with dark brown, the narrower median stripe slightly interrupted at caudal margins of segments, the sublateral stripes broader and more nearly continuous; lateral borders of tergites broadly whitish; remainder of tergites, including the interspaces and caudal borders of segments bright yellow; eighth and succeeding segments darkened; sternites uniformly clear light gray, only the narrow posterior borders pale yellow. Ovipositor (Plate 3, fig. 36, *o*) with the segments suddenly narrowed, as normal for the subgenus; cerci pale, outer margins a little dilated before tips.

Habitat.—Eastern Siberia (Jakutsk).

Holotype, female, between Ajan and Nelkan, Tongi River Valley, 137° 30′ east longitude, 56° 40′ north latitude, June 9 to 15, 1903 (*Popoff*), No. 441.

The nearest ally is *Tipula* (*Arctotipula*) *gavronskii* sp. nov., which is readily told by the strongly darkened wings, different thoracic coloration, dark median stripe on abdominal sternites, abundant macrotrichia on outer veins of wings, and other characters.

TIPULA (ARCTOTIPULA) TUNDRENSIS sp. nov. Plate 1, fig. 10; Plate 3, figs. 37, 38.

General coloration gray, the præscutum with three slightly darker gray stripes; antennæ black, relatively short; wings brown, marmorate with whitish and sparse darker brown areas; abdomen dark gray throughout; male hypopygium with the caudal margin of eighth sternite provided with hair pencils; ovipositor not conspicuously narrowed, the cerci relatively wide, with smooth margins.

Male.—Length, about 14 millimeters; wing, 15; antenna, about 3.8.

Female.—Length, about 17 millimeters; wing, 14.5.

Frontal prolongation of head gray; nasus stout; palpi black. Antennæ black, the scape pruinose; pedicel sometimes more or less reddish at tips; flagellar segments relatively short but still longer than the verticils; terminal segment thimble-shaped. Head gray.

Mesonotum gray, the præscutum with three slightly darker gray stripes that are poorly indicated. Pleura gray, the dorsopleural membrane buffy. Halteres yellow, the knobs infuscated. Legs with the coxæ pruinose; trochanters black; femora deep reddish brown, the tips blackened; tibiæ dark brown; tarsi black. Wings (Plate 1, fig. 10) brown, marmorate with whitish and sparse darker brown areas, the most evident of the latter being

the stigma; restricted paler brown areas at origin of Rs and on anterior cord; the whitish areas include a post-stigmal fascia extending from C to cell R_5; a prestigmal brightening in cell R_1; a large spot near outer end of cell M, extending caudad into cell Cu; other whitish areas nearer wing base, including an arcuate line from base of cell M, through cells Cu and 1st A, to outer end of latter cell; veins brown. Macrotrichia of veins beyond cord restricted, being limited to a series of about a dozen on outer third of vein R_{4+5}, with very sparse scattered trichia on vein R_3, outer ends of M_1, M_2, and M_3, and a short series at midlength of distal section of Cu_1. Venation: R_{1+2} entire; cell 1st M_2 long, its inner end pointed; M_{3+4} about one-half the elongate basal section of M_3; petiole of cell M_1 a little longer than m.

Abdomen dark gray throughout; tergites with basal transverse impressed punctures. Male hypopygium (Plate 3, fig. 37) with the tergite separated from sternite; basistyle, *b*, relatively large, entirely distinct from sternite. Ninth tergite (Plate 3, fig. 38, 9*t*) with a broad V-shaped median notch, the sublateral lobes low and obtuse; on ventral face of tergite a further extension of the plate, apparently homologous with the tergal saucer of *Vestiplex* but confined to ventral surface of tergite; dorsal surface of tergite with very tiny setigerous punctures. A fingerlike appressed lobe, directed mesad and ventrad, lies at caudal margin of basistyle and ninth sternite. Eighth sternite (Plate 3, fig. 37, 8*s*) with caudal margin conspicuously armed, the median portion deeply emarginate, membranous, with a transverse row of long yellow setæ, each lateral angle with a pencil of still longer setæ, the pencil so dense and abundant as to appear almost like a spine. Penis unusually stout and relatively short; ædeagus, *a*, broad-based. Terminal segments of abdomen glabrous or with very small setæ only. Ovipositor with the cerci (Plate 3, fig. 38) unusually widened, somewhat as in *Vestiplex*, but the margins smooth; hypovalvæ short, about one-third the length of the cerci.

Habitat.—Eastern Siberia (Kamchatka).

Holotype, male, Volcano Kluchevskoi, Kyrgurich, altitude 3,000 to 4,000 feet, June 12, 1909 (*Dershavin*), No. 394. Allotype, female, Kljuchevskoje Village, altitude 3,000 feet, July 4, 1909 (*Dershavin*), No. 360. Paratypes, 1 female, with allotype, June 10, 1909, No. 355; 1 female, Petropavlovsk, June 1, 1908 (*Dershavin*), No. 367.

The present fly bears a superficial resemblance to *Tipula* (*Vestiplex*) *kamchatkana* sp. nov., with which it was associated in collections. It is a very different fly and seems to be more correctly placed in *Arctotipula*, the margins of the cerci being smooth.

TIPULA (LUNATIPULA) POLYPOGON sp. nov. Plate 1, fig. 11; Plate 3, figs. 39, 40.

General coloration grayish yellow, the median præscutal stripe a little darker, bordered laterally by brown; antennæ (male) relatively short, flagellum dark brown; wings yellowish gray, unmarked except for stigma; cell 1st M_2 relatively small; outer abdominal segments blackened; male hypopygium large, unusually complicated by tufts and brushes of yellow setæ, especially on eighth sternite.

Male.—Length, about 15 millimeters; wing, 18; antenna, 4.5.

Female.—Length, about 20 millimeters; wing, 18.

Frontal prolongation moderately long, yellow; nasus short and stout; basal segment of palpus yellowish brown, the remaining segments brownish black. Antennæ (male) relatively short, if bent backward extending about to the wing root; scape and pedicel yellow, flagellum dark brown; basal enlargement of segments of medium size; verticils exceeding the segments; terminal segment about one-half the penultimate. Head buffy yellow.

Mesonotum obscure yellow or grayish yellow, with a poorly indicated, more brownish yellow, median stripe that is best indicated by the narrow brown margins; lateral stripes obsolete; scutum yellowish gray, the centers of lobes somewhat darker; posterior sclerites of mesonotum more buffy. Pleura buffy yellow, the dorsopleural membrane somewhat clearer. Halteres pale, the knobs darkened. Legs with the coxæ pale yellow; trochanters yellow; femora yellow, the tips narrowly and weakly darkened; tibiæ and tarsi brownish yellow, the outer tarsal segments more darkened. Wings (Plate 1, fig. 11) yellowish gray; prearcular and costal regions clearer yellow; stigma brown; obliterative areas at cord conspicuous; veins brown. Venation: R_{1+2} entire; cell 1st M_2 small; M_{3+4} about one-half the basal section of M_3.

Abdomen with the basal segments yellow, narrowly trivittate with brown, the sublateral stripes more distinct than the median one; segments eight and nine blackened. In the female, the three tergal stripes are broader and more distinct, especially on outer segments. Male hypopygium (Plate 3, fig. 39) large; tergite, 9*t*, entirely separated from sternite, 9*s*, by wide mem-

brane; basistyle large but incomplete, separated from sternite by a deep, membranous, ventral suture and a longer but fainter dorsal impressed line. Ninth tergite (Plate 3, fig. 39, 9*t*) of moderate size, gently narrowed outwardly, the caudal margin with a U-shaped notch; sublateral lobes obtuse, near apex with a small, slender protuberance that is directed ventrad and mesad; on ventral face of tergite, in longitudinal alignment with the above, a second pair of similar darkened lobules. Outer dististyle (Plate 3, fig. 40, *od*) broadly spatulate. Inner dististyle, *id*, with a conspicuous caudal or outer arm, the apex of which is truncated, the outer margin of both arms of style fringed with long setæ. Ninth sternite, at junction with basistyle, with a pendulous lobe that is densely clothed with long yellow setæ; cephalad of this, a conspicuous armature of chitinized hooks, as shown. Eighth sternite (Plate 3, fig. 40, 8*s*) unusually complicated by lobes and setal brushes; median region with a deep emargination filled with membrane, bearing two pairs of lobes: A larger, more caudal pair, before apex with a powerful reddish spine decussate at midline with its mate of the opposite side; inner face of this lobe with abundant long yellow setæ that extend the entire length of lobe, the more basal ones coarser; the more cephalic pair of sternal lobes lie closer to the midline, each with a long brush of yellow setæ that are directed ventrad. Ovipositor with cerci long and slender, straight.

Habitat.—Eastern Siberia (Kamchatka).

Holotype, male, Kljuchevskoje Village, 160° 20′ east longitude, 56° 40′ north latitude, June 2, 1909 (*Dershavin*), No. 364. Allotopotype, female, July 6, 1909, 363. Paratopotype, male, June 15, 1909, No. 366.

The present fly is very distinct from other regional members of the subgenus. It is allied to European species such as *Tipula peliostigma* Schummel, *T. selene* Meigen, and others, but is well-distinguished by the size and structure of the male hypopygium.

TIPULA (LUNATIPULA) LAMENTARIA sp. nov. Plate 1, fig. 12; Plate 3, figs. 41, 42.

General coloration gray and yellow, the præscutum with more brownish gray stripes that are poorly delimited; basal three antennal segments yellow, the remainder chiefly brownish black; wings pale brown, sparsely variegated by darker brown and whitish; petiole of cell M_1 short, cell 1st M_2 long; male hypopygium with the tergite large, the median region entirely pale, membranous; each lateral lobe flattened, divergent; a single dististyle; a conspicuous fleshy lobe extends caudad from the pos-

terior portion of the basistyle; eighth sternite with a terminal brush of yellow setæ.

Male.—Length, about 13 millimeters; wing, 15.5; antenna, 4.5.

Frontal prolongation of head testaceous-yellow; nasus slender; palpi brownish black. Antennæ (male) of moderate length, if bent backward extending about to mid-distance between the bases of wings and halteres; basal three segments of antennæ light yellow; remainder of organ almost uniformly brownish black, the basal enlargements a little darker; verticils very long, exceeding the segments. Head gray.

Mesonotal præscutum gray, with darker, more brownish gray stripes that are very poorly defined; scutal lobes variegated by darker; scutellum brown; mediotergite testaceous-yellow. Pleura brownish yellow, the dorsopleural region clearer yellow; ventral sternopleurite weakly darkened. Halteres pale yellow, the knobs infuscated. Legs with the coxæ whitish yellow; trochanters yellow; femora light yellow, the tips narrowly but conspicuously blackened; tibiæ pale brown, the tips darker; tarsi pale brown, the outer segments darker brown. Wings (Plate 1, fig. 12) with the ground color pale brown; prearcular and costal regions light yellow; stigma small, pale brown, confluent with a cloud on anterior cord; small but conspicuous obliterative areas before stigma and across cell 1st M_2; veins brown, paler in the yellow areas. Macrotrichia of veins beyond cord relatively numerous, lacking on distal half of R_{1+2}. Venation: R_{1+2} entire; cell M_1 with petiole short, varying in length from about one-half m to subsessile; cell 1st M_2 long, parallel-sided; M_{3+4} short, less than one-third the basal section of M_3, the fork thus lying proximad of r-m.

Abdomen more or less discolored in type, apparently dark reddish brown, the outer segments still more darkened. Male hypopygium (Plate 3, fig. 41) with the tergite, 9*t*, entirely separate from the sternite, 9*s*, by membrane; basistyle very small, entirely cut off by sutures; at point of union of sternite and basistyle is a stout cylindrical lobe, directed caudad, pale in color, provided with long conspicuous setæ. Ninth tergite (Plate 3, fig. 42, 9*t*) large, each half entirely divided by pale membrane, the lateral lobes appearing as broad, flattened, divergent blades that gradually narrow to the subacute tips; median-caudal portion of tergite a little produced, the margin obtuse. A single dististyle (Plate 3, fig. 41, *d*), compressed, the

posterior margin coarsely and irregularly denticulate; surface of style with scattered setæ, those at point of attachment of basistyle very abundant and delicate. Eighth sternite (Plate 3, fig. 41, 8*s*) moderately sheathing, narrowed outwardly, the apex gently notched and provided with a brush of long yellow setæ. Ædeagus (Plate 3, fig. 42, *a*) elongate, blackened, the apex terminating in two acute black spines.

Habitat.—Eastern Siberia (Ussuri).

Holotype, male, between Chhil and Wakar, Amur River, July 29, 1908 (*Soldatov*), No. 661.

The general appearance of the present fly is somewhat like the Nearctic *Tipula mainensis* Alexander, but the two species are very distinct. The broad membranous median strip of the tergite of the hypopygium is similar to that found in many *Vestiplex* species. In certain structures, the fly suggests some European species of *Lunatipula*, as *peliostigma* Schummel and *selene* Meigen, but the resemblance is not particularly close.

TIPULA (LUNATIPULA) LUNDSTRÖMIANA sp. nov. Plate 1, fig. 13; Plate 4, figs. 43, 44, 45.

Belongs to the *serta* group; nasus lacking; general coloration gray, the præscutum with four brown stripes; antennæ (male) long, the flagellar segments strongly incised; male hypopygium with the caudal margin of sternite produced medially into a depressed plate that is further extended into two long straight spines.

Male.—Length, about 16 millimeters; wing, 16; antenna, about 6.5.

Female.—Length, 22 to 23 millimeters; wing, 19 to 20.

Frontal prolongation of head elongate, without nasus, brownish gray above, brighter laterally beneath; palpi brownish black. Antennæ of male (Plate 4, fig. 43) long, if bent backward extending to shortly beyond base of abdomen; scape and pedicel yellow, flagellum black; flagellar segments very strongly incised, about as in *excisa*. Head light gray, with a capillary blackish line on posterior vertex.

Mesonotal præscutum light gray, with four brown stripes; scutum light gray, the lobes variegated with darker gray; posterior sclerites of notum gray, the mediotergite with a median dusky vitta. Pleura gray, the dorsopleural region light yellow; mesopleura glabrous. Halteres yellow, the knobs dark brown. Legs with the coxæ light gray; trochanters yellow; femora yellow, the tips narrowly and gradually infuscated; tibiæ yellowish brown, darkened outwardly; tarsi black. Wings (Plate 1, fig.

13) brownish, the prearcular and costal regions more yellowish; stigma dark brown; anterior cord clouded with brown; an incomplete whitish crossband beyond stigma, extending to cell 1st M_2 (male) or into base of M_3 (female); a whitish spot near outer end of cell M, small in male, larger and more conspicuous in female; veins brown. Macrotrichia of veins beyond cord numerous and well-distributed; squama naked. Venation: $_{1+2}$ entire, with trichia to tip or nearly so; cell 1st M_2 long, narrowed at outer end; M_{3+4} varying from very short, about one-half m, to fully as long as this element.

Abdomen with the first tergite brown, the succeeding segments yellow, the tergites weakly darkened medially, much more strongly so in female; indications of a less clearly defined sublateral stripe; lateral margins narrowly pale; outer segments infuscated; sternites of female darkened and pruinose. Male hypopygium (Plate 4, fig. 44) with the tergite, 9*t*, separate from sternite, 9*s;* basistyle, *b*, very large, entirely separate, the caudal end narrowed but scarcely produced. Ninth tergite (Plate 4, fig. 45, 9*t*) subquadrate, transverse; caudal margin with five projections, including a nearly lateral pair of slender flattened blades, their tips obtuse; a shorter and broader median black lobe, and a pair of small acute teeth between the other projections; dorsomedian region of tergite narrowly impressed, without setæ; lateral lobes, viewed from side, with a ventral expansion near base. Outer dististyle, *od*, cylindrical, slender, with abundant coarse setæ. Inner dististyle (Plate 4, fig. 45, *id*) tridentate at apex. Region of junction of ninth sternite and basistyle (Plate 4, fig. 44, 9*s*) with a long pale fleshy lobe directed ventrad and mesad, the narrowed tips contiguous on the midline. Eighth sternite (Plate 4, fig. 45, 8*s*) with the caudal margin transverse or nearly so, the only armature being a conspicuous median depressed plate that narrows outwardly, terminating in two acute straight spines that inclose a deep, parallel-sided U-shaped notch. As in the similar bidentate lobe of *serta,* there is some variation in size and shape of the plate in different individuals.

Habitat.—Eastern Siberia (Amur, Saghalien).

Holotype, male, Beitonovo Station, Amur River, May 31, 1915 (*Popoff*), No. 630. Allotopotype, female, No. 631. Paratypes, 1 teneral male, Osernaja, Amur River, June 10, 1913, No. 664; 1 male, Saghalien (*Suprunenko*), No. 526; 1 female, Amur (*Suprunenko*), No. 529.

I dedicate this distinct species to the memory of the late Carl Lundström, distinguished authority on the Nematocera of Finland and Arctic Asia. The closest allies are *T. subexcisa* Lundström, of northern Europe, and *T. serta* Loew, of northern North America; from the former it is readily told by the armature of the eighth sternite of the male hypopygium, where the small, widely separated fleshy lateral lobes of *subexcisa* are replaced by the median bidentate plate described; *serta,* while very different from the present species in its general appearance, especially the wing pattern, approaches it in the structure of the male hypopygium, the general features being very similar in the two flies. The bidentate sternal plate is smaller in *serta,* but has nearly the same conformation. I believe that the members of the *serta* group are correctly placed in *Lunatipula* despite the conspicuous lack of a nasus.

TIPULA (LUNATIPULA) FLACCIDA sp. nov. Plate 1, fig. 14; Plate 4, figs. 47, 48.

Belongs to the *serta* group; general coloration of mesonotum light gray, with four slightly darker gray stripes; antennæ (male) relatively long, the flagellar segments only feebly incised; femora yellow, the tips narrowly dark brown; wings grayish, with a restricted whitish and dark brown pattern; male hypopygium with a small obtuse median lobe between the slender lateral arms of tergite; eighth sternite with a horn-shaped lobe on either side, these gradually narrowed to the tips.

Male.—Length, about 16 millimeters; wing, 17.5; antenna, about 6.

Frontal prolongation of head long and conspicuous, brown, sparsely pruinose dorsally, more yellowish ventrally beneath; nasus lacking; palpi with basal segment yellow, succeeding segments pale brown, the terminal segment passing into brownish black. Antennæ (Plate 4, fig. 46) relatively long; basal three segments yellow, the remainder brownish black; flagellar segments only feebly incised; longest verticils about equal to the segments. Head light gray, with a faintly indicated median dusky vitta.

Mesonotal præscutum light gray, with four scarcely indicated darker gray stripes, the intermediate pair separated by a darker vitta; scutum light gray, the lobes indistinctly variegated by darker gray; posterior sclerites of notum gray. Pleura light gray, with large darker gray areas on ventral anepisternum, ventral sternopleurite, and meron; dorsopleural region yellow. Halteres yellow, the knobs dark brown. Legs with the coxæ gray; trochanters yellow; femora yellow, the tips narrowly dark

brown, the amount subequal on all legs and not exceeding the distal seventh or eighth; tibiæ and tarsi brown, the outer tarsal segments blackened. Wings (Plate 1, fig. 14) grayish, with a restricted whitish and dark brown pattern that is arranged much as in *sublimitata;* post-stigmal whitening restricted, including cells Sc_2 and R_2; obliterative streak along cord more extensive and conspicuous, involving the base of cell M_3; stigma dark brown; narrow brown seams on anterior and posterior cords; veins brown. Macrotrichia of veins numerous. Venation: Second section of R_1 slightly shorter than free tip of Sc_2.

Abdomen yellow, the tergites trivittate with brown, the areas extensive but not well-delimited; terminal segments and hypopygium uniformly blackened. Male hypopygium (Plate 4, fig. 47) of moderate size, the tergite, 9*t*, and basistyle, *b*, entirely cut off from sternite, 9*s*, by deep, membranous sutures. Ninth tergite (Plate 4, fig. 47, 9*t*) narrowed outwardly, the caudal margin conspicuously emarginate; lateral lobes narrowed into slender blackened blades, their tips truncated; at base of emargination a small obtuse blackened lobe. Basistyle with a group of long scattered setæ. Outer dististyle small, cylindrical. Inner dististyle (Plate 4, fig. 48, *id*) with a conspicuous digitiform lobe at base. Junction of sternite and basistyle with a blackened lobe that is directed ventrad, provided with sparse scattered yellow setæ. Eighth sternite (Plate 4, fig. 48, 8*s*) having the surface with small delicate setæ only; caudal margin with a broad notch filled with membrane; a horn-shaped lobe at each lateral angle of emargination, each narrowed to a subacute point, the mesal surface with a few, scattered, coarse, yellow setæ.

Habitat.—Eastern Siberia (Ussuri).

Holotype, male, Volok Bay, Vladivostok, August 4, 1912 (*Czerski*), No. 727.

The nearest ally is *Tipula* (*Lunatipula*) *sublimitata* Alexander, of Kamchatka,[4] which differs chiefly in the structure of the male hypopygium, especially the tergite and eighth sternite. In the latter species, the lateral lobes of the sternite are broad-based with the tips blunt and expanded.

TIPULA (LUNATIPULA) DERSHAVINI sp. nov. Plate 1, fig. 15; Plate 4, fig. 49.

Allied to *senega;* general coloration of mesonotum olive-gray, the præscutum with four ill-defined darker gray stripes; antennæ with three basal segments yellow, the remainder chiefly brownish black; wings with a faint brown tinge, an incomplete

[4] Arkiv för Zoologi 19A, No. 9 (1927) 8–10, figs. 4, 5.

whitish crossband beyond cord; male hypopygium with the tergite notched, produced medially into an obtuse triangular lobe; eighth sternite produced medially into a flattened plate, the apex notched, the ventral margins toothed.

Male.—Length, about 14 millimeters; wing, 15; antenna, about 4.5.

Female.—Length, about 20 millimeters; wing, 18.5.

Frontal prolongation of head obscure yellow; nasus conspicuous; palpi dark brown, the basal segment obscure yellow. Antennæ with the basal three segments yellow, the remainder nearly uniform brownish black, the basal enlargements a little darker; flagellar segments moderately incised; verticils nearly as long as the segments; terminal segment small, thimble-shaped. Head olive-gray, the midline of posterior vertex a little darkened.

Mesonotal præscutum olive-gray, with four darker brownish gray stripes that are ill-defined against the ground, the mesal edges of anterior ends of intermediate stripes a little darker; scutum greenish gray, the lobes variegated with darker; posterior sclerites of notum chiefly gray. Pleura whitish, the ventral anepisternum and ventral sternopleurite light gray; dorsopleural membrane buffy; pleura glabrous. Halteres yellow, the knobs infuscated. Legs with the coxæ obscure whitish; trochanters yellow; femora obscure yellow, the narrow tips weakly and very indistinctly darkened; tibiæ brownish yellow; tarsi passing into brownish black. Wings (Plate 1, fig. 15) with a faint brown tinge; prearcular and costal regions clearer yellow; stigma and a narrow brown seam on anterior cord pale brown; an incomplete whitish crossband beyond cord, extending from costa to cell 1st M_2, narrowed behind; whitish obliterative areas before stigma and across cell 1st M_2; veins brown. Macrotrichia on veins beyond cord sparse but well-distributed; squama without well-developed setæ. Venation: R_{1+2} entire; M_{3+4} short, less than m.

Abdominal tergites obscure brownish yellow, with a broad diffuse brownish median stripe and narrow, interrupted, sublateral, brown stripes; lateral borders of segments broadly grayish white; sternites yellow, the outer segments more darkened. Male hypopygium (Plate 4, fig. 49) with the tergite, 9*t*, separate from sternite, 9*s*; basistyle relatively large, almost completely separated from sternite, fused for a short distance near the ventral suture. Ninth tergite, 9*t*, of the general type of *senega*

or *serta;* lateral lobes relatively slender; median area conspicuously produced into a blunt triangular point. From the membrane at end of ventral suture of basistyle hangs pendant a large pale fleshy lobe that is clothed with abundant pale setæ. Basistyle with outer end narrowed to an obtuse point. Outer dististyle very small, cylindrical, with conspicuous setæ. Inner dististyle, *id,* massive. Phallosome, *p,* trifid, the median lobe microscopically bifid at apex. Eighth sternite, 8*s,* with the caudal margin complexly armed; lateral lobes with margins feebly sclerotized, directed mesad, touching one another at midline, clothed with relatively conspicuous setæ; median region of sternite produced caudad into a flattened chitinized blade, depressed, the apex with a U-shaped notch, the ventral margins (as viewed laterally) thickened and set with about three conspicuous teeth; at base of median plate, just cephalad of the lateral lobes, a small acute point that is directed strongly caudad.

Habitat.—Eastern Siberia (Kamchatka, Ussuri).

Holotype, male, Kljuchevskoje Village, Kamchatka, 160° 20′ east longitude, 56° 40′ north latitude, July 5, 1909 (*Dershavin*), No. 358. Allotype, female, Suchan district, Trolovka, Ussuri, July 6, 1926 (*Mordvilko*), No. 619. Paratopotype, female, with type, No. 356.

The present fly is undoubtedly allied to the Nearctic *Tipula senega* Alexander, despite the somewhat different wing pattern. The peculiar conformation of the ninth tergite and eighth sternite of the male hypopygium are very suggestive of the same structures in *senega,* but the details are quite distinct. The superficial appearance is much as in the Japanese *Tipula pendula* Alexander, but the hypopygium of the latter is entirely different. The paratype may not be conspecific with the type, as the white band beyond cord of wings is not defined and the tips of the femora are narrowly darkened.

TIPULA (LUNATIPULA) LÆTIBASIS sp. nov. Plate 1, fig. 16; Plate 4, figs. 50, 51.

Allied to *sachalinensis;* general coloration gray, the mesonotal præscutum with four darker gray stripes, the intermediate pair narrowly separated and without further median darkening; wing base conspicuously light yellow; male hypopygium with the caudal margin of tergite broadly emarginate, without denticles except a single outer point on each lobe; inner dististyle with the heel portion dusky, terminating in several small spines.

Male.—Length, about 13 to 14 millimeters; wing, 12 to 12.5.

Female.—Length, 18 to 22 millimeters; wing, 13.5 to 16.5.

Generally similar and closely allied to *Tipula sachalinensis* Alexander, differing especially in the coloration of the mesonotal præscutum and in the structure of the male hypopygium.

Coloration bluish gray, the head with a median darker line. Mesonotal præscutum with four dark stripes, the intermediate pair clearly but narrowly separated and without indications of a further capillary median vitta, as in *sachalinensis;* lateral margins of præscutum undarkened. Femoral tips conspicuously blackened, somewhat more broadly so in the Honshu paratype. Wings (Plate 1, fig. 16) with the prearcular cells conspicuously light yellow in both sexes; dark pattern highly contrasted, especially in female. Abdomen with caudal margins of outer segments conspicuously ringed with yellow, the lateral margins of tergites more buffy; abdomen with a heavy light gray bloom. Male hypopygium in essentials much as in *sachalinensis,* as in the notched ninth tergite, complete basistyle, and armed eighth sternite. Ninth tergite (Plate 4, fig. 50, 9*t*) with the caudal margin gently emarginate to form a large U-shaped notch, the base of which has a further quadrate incision that bears a tiny median tooth at base; no denticles along caudal border of tergite; dorsal surface back from median incision with a depressed groove. Outer dististyle cylindrical. Inner dististyle, *id,* much as in *sachalinensis,* but the heellike portion is borne on side of sclerite, appearing as a dusky plate having each outer angle with about three coarse teeth. Junction of ninth sternite and basistyle on either side with a small lobe that is suddenly narrowed outwardly, the apex tufted, 9*s*. Eighth sternite with the caudal margin emarginate, filled with pale membrane; each lateral angle bears a pencil of long setæ, mesad of which are smaller setæ.

In *Tipula sachalinensis* the tergite (Plate 4, fig. 51, 9*t*) has the caudal margin transverse or even slightly convex, with a deep median notch, the lateral lobes thus formed truncate, with small spinous points. Inner dististyle, *id,* with the heel portion projecting as a subrectangular yellow lobe, its apex truncated, the surface with delicate microscopic setulæ, but without spines of any sort. Lobes of the ninth sternite longer, more evenly cylindrical, with long conspicuous setæ.

Habitat.—Eastern Siberia, Japan.

Holotype, male, Bay De Castries, Ussuri, June 19, 1910 (*Derbeck*), No. 318. Allotype, female, River Kamchatka, Kamchatka, 1898 (*Gondatti*), No. 590. Paratypes, 1 female, Dshalinda,

Reinovo, Amur, June 9 to 30, 1915 (*Poroff*), No. 624; 1 female, Ichinosawa, Saghalien, July 9, 1924 (*M. Tamanuki*); 1 female, Norikuradake, Japanese Alps, Honshiu, Japan, July 26, 1929 (*Machida*).

The only fly that can be confused with *Tipula* (*Lunatipula*) *lætibasis* is *T.* (*L.*) *sachalinensis* Alexander, which has been sufficiently compared in the above description. The Japanese paratype had earlier [5] been recorded as *sachalinensis*, but the discovery of the male sex has shown the present fly to be quite distinct.

TIPULA (LUNATIPULA) GONDATTII sp. nov. Plate 1, fig. 17; Plate 4, figs. 52, 53.

Allied to *trispinosa;* mesonotum light gray, the præscutum with four, scarcely evident, darker gray stripes; wings with the ground color yellowish gray, stigma pale brown; male hypopygium with the outer lateral angles of tergite produced into slender blackened horns; outer dististyle very small.

Male.—Length, about 11 to 13 millimeters; wing, 12.5 to 14; antenna, about 4.

Female.—Length, about 12 millimeters; wing, 12.

Frontal prolongation of head relatively long, gray; nasus lacking; palpi brown, the incisures pale. Antennæ with the scape infuscated; pedicel light yellow; flagellum black; segments with basal enlargement moderately developed, the verticils a trifle shorter than the segments. Head gray.

Mesonotal præscutum light gray, with four scarcely apparent darker gray stripes, the lateral pair especially indistinct; posterior sclerites of notum gray, the scutellum a little more yellowish. Pleura gray, the posterior sclerites paler; dorsopleural region yellow. Halteres yellow, the knobs infuscated. Legs with the coxæ light gray; trochanters yellow; femora yellow, the tips conspicuously blackened, the amount subequal on all legs, including approximately the distal sixth or less; tibiæ and tarsi light brown, the terminal tarsal segments darker brown. Wings (Plate 1, fig. 17) yellowish gray, the prearcular and costal regions light yellow; stigma pale brown; obliterative streak before cord relatively conspicuous, extending into base of cell M_3; veins pale brown, more yellowish in the brightened areas. Macrotrichia well distributed on veins beyond cord. Venation: R_{1+2} entire; cell 1st M_2 of moderate size for a member of the group.

Abdominal tergites reddish yellow, on the fourth and succeeding segments more blackish gray, with broad pale lateral mar-

[5] Philip. Journ. Sci. 44 (1931) 339.

gins; sternites beyond the second blackish gray; hypopygium black. Male hypopygium (Plate 4, fig. 52) with the tergite, 9*t*, and basistyle entirely distinct from sternite, the latter small. Ninth tergite (Plate 4, fig. 52, 9*t*) large, black, with a profound spade-shaped median incision, the lateral arms narrowed into slender, gradually diverging lobes, the cephalic sclerotized bar narrow. Outer dististyle a tiny blacked lobe. Inner dististyle (Plate 4, fig. 53, *id*) relatively small, extended into a simple apical beak. Eighth sternite (Plate 4, fig. 53, 8*s*) sheathing, each outer lateral angle bearing a slender, inconspicuous lobe that is narrowed to an acute point, the surface with small setulæ. Ovipositor with small fleshy valves, as in the *fascipennis* group.

Habitat.—Eastern Siberia (Saghalien, Ussuri).

Holotype, male, Nikolajevsk, Amur River, Ussuri, June 23, 1914 (*Bjeloussov*), No. 535. Allotopotype, female, No. 537. Paratopotype, 1 female, No. 536. Paratypes, 2 males, Chaivo, Saghalien, 142° east longitude, 52° north latitude, July 12, 1910 (*Derbeck*), Nos. 322, 324; 4 of both sexes, Dui, Saghalien, June 20, 1914 (*Bjeloussov*), Nos. 544, 545, 547, 550.

I take pleasure in dedicating this distinct fly to Mr. Gondatti, leader of several expeditions to eastern Siberia in behalf of the Russian Academy of Sciences. The nearest ally is *Tipula* (*Lunatipula*) *trispinosa* Lundström, of Finland, which has all details of the male hypopygium quite distinct.

TIPULA (LUNATIPULA) DERBECKI sp. nov. Plate 1, fig. 18; Plate 5, fig. 54.

General coloration gray, the præscutum with four, poorly defined, darker gray stripes; antennæ (male) short, if bent backward not reaching the wing root; scape and pedicel yellow; flagellum with basal segments bicolorous; femora yellow, the tips narrowly brownish black; wings grayish brown with a restricted brown and white pattern, the former including a conspicuous spot at near midlength of cells M and Cu; a short poststigmal white crossband; R_{1+2} entire; male hypopygium with the ninth tergite notched medially, the lateral lobes broad; inner dististyle with caudal end produced into a long, powerful, black spine; eighth sternite moderately sheathing, terminating in two small, fleshy, pendant lobes.

Male.—Length, about 13.5 millimeters; wing, 15; antenna, about 3.

Frontal prolongation of head black, sparsely pruinose; nasus long and slender; palpi black. Antennæ (male) relatively short, if bent backward ending some distance before wing root; scape

and pedicel yellow; basal flagellar segments bicolorous, black basally, reddish brown apically, the outer segments more uniformly blackened; longest verticils nearly equal in length to segments. Head gray pruinose, discolored in type.

Mesonotum gray, the præscutum with poorly defined darker gray stripes; scutal lobes similarly marked with dark gray; scutellum dark gray; mediotergite light gray. Pleura gray; dorsopleural region buffy. Halteres pale yellow, knobs dark brown. Legs with the coxæ light gray; trochanters yellow; femora yellow, the tips narrowly brownish black; tibiæ yellow, the tips narrowly darkened; tarsi obscure yellowish brown at base, passing into black; forelegs broken. Wings (Plate 1, fig. 18) with the ground color grayish brown, with a restricted brown and whitish pattern; the brown areas include the stigma and a confluent area on anterior cord; a small spot at origin of Rs; a large paler brown cloud at midlength of cells M and Cu, preceded and followed by more-whitish areas; a restricted whitish mark beyond stigma, extending from costa to cell R_5, becoming more obscure behind; axilla narrowly darkened; veins brown. Macrotrichia of veins very numerous, lacking on 1st A, with exception of a single trichium at outer end; squama naked. Venation: R_{1+2} pale, entire, diverging strongly from R_3, cell R_2 relatively small; M_{3+4} about two-thirds the basal section of M_3.

Abdomen with basal tergite gray; tergites two and three yellow, narrowly trivittate with brown, on the outer segments becoming more extensive so as to include virtually the whole segment; lateral borders of tergites pale; basal sternites yellow, the outer segments dark brownish gray. Male hypopygium (Plate 5, fig. 54) with the tergite, 9*t*, entirely separate from the sternite, 9*s*, by extensive pale membrane. Basistyle, *b*, very large, the suture separating it from sternite delicate but complete. Ninth tergite, 9*t*, broad, darkened but not heavily sclerotized, the main body massive, the caudal margin extended into a paler portion that bears a U-shaped median notch; lateral lobes very broad, obliquely truncated; mid-dorsal area of tergite depressed, without setæ. Outer dististyle, *od*, pale, long, and slender, still paler and more or less constricted at midlength, the apex narrowed. Inner dististyle, *id*, elongate, parallel-sided or even a little dilated outwardly, the ventral or caudal end produced into a powerful smooth black spine, its apex acute. Eighth sternite sheathing, the apex at midline with two small pale lobes that are pendant or recurved.

Habitat.—Eastern Siberia (Amur).

Holotype, male, Cape Dshaore, mouth of Amur River, 141° 15′ east longitude, 53° north latitude, June 19, 1910 (*Derbeck*), No. 312.

This very interesting *Tipula* is dedicated to the collector of this and other noteworthy crane flies from Amur and Saghalien. The peculiar structure of the male hypopygium, especially of the inner dististyle, readily separates the present fly from allied similar forms. The spinous extension of the inner dististyle suggests *Tipula apicispina* Alexander (Ussuri), which is in all other respects a very different fly.

TIPULA (LUNATIPULA) CHERNAVINI sp. nov. Plate 1, fig. 19.

General coloration gray, the præscutum with four dark brown stripes; antennæ black, the basal three segments yellow, the proximal end of scape a little darkened; femora obscure yellow, the tips rather narrowly brownish black; wings handsomely variegated with light and dark brown, together with extensive whitish areas, the latter including a complete crossband beyond cord; R_{1+2} entire; cell M_1 unusually deep, sessile; basal abdominal tergites reddish yellow, with three brown stripes; basal sternites dark gray.

Female.—Length, about 20 millimeters; wing, 18.5.

Frontal prolongation of head light gray above, the ventral half beneath brownish black; nasus elongate, stout; palpi black. Antennæ with the basal three segments yellow, the proximal end of scape a little infuscated, the first flagellar segment a little more darkened than the pedicel; remainder of antennæ black; longest verticils exceeding segments; terminal segment nearly two-thirds the penultimate. Head light gray.

Mesonotal præscutum light gray with four dark brown stripes, the intermediate pair narrow and more intense in color than the laterals; scutal lobes variegated with dark brown; posterior sclerites of notum gray, the mediotergite with a capillary dark line. Pleura gray, the dorsopleural region more buffy. Halteres broken. Legs with the coxæ light gray; trochanters yellow; femora obscure yellow, the tips rather narrowly brownish black; tibiæ light brown, the tips narrowly blackened; tarsi light brown at bases, passing into black. Wings (Plate 1, fig. 19) with the ground color relatively dark brown, highly variegated with whitish and darker brown; prearcular and costal regions yellow; stigma dark brown, confluent with a similar area on anterior cord; dark spot at origin of Rs small; the extensive

white areas are as follows: A broad complete crossband beyond cord; extensive areas in cells R_1, outer end of cell R, the latter confluent with a similar but smaller area in outer end of cell M; a large basal whitening, involving cells R to 1st A, inclusive; bases of anal cells pale; veins brown, light yellow in the whitish areas. Macrotrichia of veins beyond cord relatively numerous and well-distributed; squama naked. Venation: R_{1+2} entire but very pale beyond base; cell M_1 sessile; M_{3+4} less than one-half the basal section of M_3; m-cu on M_4 shortly beyond origin.

Abdomen destroyed beyond midlength; basal tergite and proximal ring of tergite two dark gray; succeeding tergites reddish yellow, the median region dark brown; on third and succeeding tergites a conspicuous sublateral stripe begins; basal four sternites dark gray, with only the base of second narrowly yellow; segments beyond fourth broken.

Habitat.—Eastern Siberia (Amur).

Holotype, female, Osernaja, mouth of Amur River, 160° 30′ east longitude, 57° north latitude, June 20 and 21, 1915 (*Chernavin*), No. 713.

This interesting crane fly is named in honor of the collector, who has taken rather numerous species of these flies at the mouth of the Amur. The fly belongs to a group of forms having vein R_{1+2} entire and with a broad, complete white crossband beyond the cord. From all regional members of this restricted group, it differs in the sessile cell M_1. The closest relative appears to be *Tipula* (*Lunatipula*) *mesacantha* sp. nov., which has cell M_1 conspicuously petiolate, and, in the male sex, at least, has the basal abdominal sternites brightened. The possibility exists that the present fly is the opposite sex of *mesacantha*.

TIPULA (LUNATIPULA) MESACANTHA sp. nov. Plate 1, fig. 20; Plate 5, figs. 55, 56.

Allied to *trupheoneura;* general coloration light gray, the præscutum with four more or less distinct brown stripes; antennæ with scape and pedicel yellow, flagellum black; wings pale brown, variegated by darker brown and whitish areas, the latter including a complete crossband beyond cord; tip of R_{1+2} pale or atrophied; male hypopygium with the lateral lobes of tergite flattened, pale, the margins irregularly toothed; median notch of tergite with a long acute spine; dorsocaudal region of ninth sternite on either side bearing two conspicuous spines of unequal sizes.

Male.—Length, about 13 to 14 millimeters; wing, 14.5 to 16; antenna, about 4 to 4.2.

Frontal prolongation of head obscure yellow, slightly pruinose above, more heavily so at base; nasus short and stout; palpi black. Antennæ with the scape and pedicel light yellow; first flagellar segment obscure yellow at base, the outer end infuscated; remainder of flagellum almost uniformly brownish black; flagellar segments moderately incised; longest verticils nearly equal in length to segments; terminal segment a mere button. Head light gray, with a median brown line, more distinct on posterior vertex; vertical tubercle relatively large.

Mesonotal præscutum light gray, with four narrow brown stripes, these subobsolete in the paratype; scutum light gray, each lobe with two conspicuous brown areas, subobsolete in paratype; scutellum brownish gray; mediotergite gray with a capillary blackish median vitta. Pleura light gray, the dorsopleural region light yellow; no setæ on mesepisternum. Halteres pale yellow, the knobs dark brown. Legs with the coxæ light gray; trochanters yellow; femora yellow, the tips brownish black, the amount subequal on all legs; tibiæ reddish brown, not or scarcely darker at tips; tarsi brown to dark brown; tibial spur formula 1–2–2; claws small, simple. Wings (Plate 1, fig. 20) pale brown, variegated by darker brown areas and very extensive whitish markings; the dark areas include the stigma and a confluent mark on anterior cord, together with a small brown spot at origin of Rs; the whitish areas include a complete crossband beyond cord, with very extensive pale areas in cells R_1, R, M, and Cu, restricting the ground almost entirely to markings in outer half of cell M; anal cells whitened basally and at near midlength of cell 1st A; prearcular and costal regions light yellow; veins brown, becoming yellowish where traversing the pale markings. Squama naked. Venation: Extreme tip of R_{1+2} very faint (in type) to entirely atrophied (in paratype), the distal two-thirds without trichia; m-cu on M_4 beyond origin.

Basal abdominal tergites reddish, with a median dark brown vitta; lateral borders narrowly gray, bordered internally by a scarcely evident dusky line; basal sternites yellow; outer abdominal segments infuscated, the hypopygium dark brown. Male hypopygium (Plate 5, fig. 55) with the tergite, 9*t*, entirely separate from the sternite, 9*s*; basistyle, *b*, entirely distinct from sternite, its caudal margin slightly but broadly produced. A small sclerite cut off from the dorsocaudal region of the ninth sternite is produced into a strong blackened spine, directed chiefly dorsad and caudad, with a second smaller spine near its

base, 9*s*. Ninth tergite (Plate 5, fig. 56, 9*t*) flattened, pale in color, the nearly lateral lobes thin, obliquely truncated at tips, the margin of lobes with weak pale denticles; the deep quadrate median notch bears at its base an unusually long and powerful acute spine that is approximately as long as the mesal edge of the lateral tergal lobes; on ventral surface of tergal plate, at base of each lobe and near the mesal edge, a small acute blackened spine, directed ventrad. Outer dististyle a setiferous clavate lobe. Inner dististyle with two blacked beaks, the outer margin near base produced into a small rounded lobe that bears several coarse black setæ.

Habitat.—Eastern Siberia (Amur, Ussuri).

Holotype, male, Osernaja, mouth of Amur River, June 20 and 21, 1915 (*Chernavin*), No. 715. Paratype, male, Golden Horn, Vladivostok, May 28, 1911 (*Rydzevski and Kuznetzov*), No. 426.

Tipula (*Lunatipula*) *mesacantha* is related to the Japanese *T.* (*L.*) *pollex* Alexander and *T.* (*L.*) *trupheoneura* Alexander, especially to the latter, but is quite distinct in the structure of the male hypopygium, the more conspicuous features being the ninth tergite, unarmed basistyle, and double spine of caudal margin of ninth sternite. As discussed under *T.* (*L.*) *chernavini* sp. nov., the possibility exists that this may be the male sex of that fly.

TIPULA MEDIOLOBATA sp. nov. Plate 1, fig. 21; Plate 5, figs. 57, 58.

Allied to *luteipennis;* general coloration of thorax gray, the præscutum with four slightly darker gray stripes that are feebly bordered by brown; male hypopygium with the tergite broadly emarginate, at base with a conspicuous median lobe that is clothed with abundant setulæ.

Male.—Length, about 13.5 to 14 millimeters; wing, 14 to 15.

Female.—Length, about 16 to 18 millimeters; wing, 15 to 16.

Frontal prolongation of head yellow; nasus distinct; basal segments of palpi yellow, outer segments broken. Antennæ with scape and pedicel yellow; flagellum broken. Head gray, the vertex medially a little darker.

Mesonotal præscutum gray, with scarcely differentiated gray stripes that are best indicated by pale brown margins; posterior sclerites of notum light gray. Pleura gray, the dorsopleural region buffy. Halteres yellow, the knobs infuscated. Legs with the coxæ light gray; trochanters yellow; femora yellow, the tips conspicuously blackened, of the tibiæ more narrowly so; tarsi passing into black. Wings (Plate 1, fig. 21) with a strong yellow tinge; stigma pale brown; obliterative streak before cord con-

spicuous; veins brown. Venation: R_{1+2} and R_3 only gradually divergent; petiole of cell M_1 short, subequal to or shorter than m.

Abdomen yellow, the basal segment pruinose; tergites with a conspicuous median brown vitta, with much narrower and less evident lateral stripes; caudal margins of segments narrowly but conspicuously pale yellow; subterminal segments more uniformly grayish brown; hypopygium extensively yellow. Male hypopygium with the caudal margin of tergite (Plate 5, fig. 57, 9*t*) conspicuously emarginate, the lobes relatively short, the entire emargination provided with abundant long black setæ that occur in several ranks throughout the entire extent; on ventral margin of tergite a conspicuous subrectangular lobe that is densely clothed with erect setulæ. Styli as shown. In *luteipennis* the lateral lobes of the tergite (Plate 5, fig. 58, 9*t*) are longer, with unusually long and dense dark setæ at apex and down the mesal edge, at base of emargination with these setæ reduced to a single row; median ventral lobe of tergite very weak and reduced, not or but little evident.

Habitat.—Eastern Siberia (Ussuri).

Holotype, male, Sidemi, August 10, 1897 (*Jankovski*), No. 482. Allotopotype, female, with type. Paratopotypes, one of each sex, with type, No. 470.

Tipula mediolobata is most readily told from the closely allied *T. luteipennis* Meigen, of Europe, by the structure of the male hypopygium. There is no darkened cloud at the end of vein 2d A of wings, as in *moiwana* (Matsumura). The subgeneric position of members of the *luteipennis* group is uncertain, but I would believe that they might be found to pertain to the typical subgenus. If a separate subgeneric group is required, the name *Platytipula* Matsumura (1916) is available.

TIPULA DOCILIS sp. nov. Plate 1, fig. 22; Plate 5, fig. 59.

Belongs to the *marmorata* group; allied to *obsoleta;* mesonotal præscutum gray, with four brown stripes; antennal scape and pedicel yellow, the flagellum black; wing pattern nearly obsolete; male hypopygium with caudal margin of tergite bearing a U-shaped notch; basistyle not apically produced; eighth sternite without noticeable armature; inner dististyle a flattened, compressed, yellow blade, with a single slender subapical blackened beak.

Male.—Length, about 12 to 13 millimeters; wing, 12 to 13.5; antenna, about 3.2.

Female.—Length, about 14 millimeters; wing, 13.

Frontal prolongation of head brown; nasus conspicuous; palpi brownish black. Antennæ (male) of moderate length, if bent backward extending about to mid-distance between bases of wings and halteres; scape and pedicel yellow, flagellum black; verticils shorter than the segments. Head gray.

Mesonotal præscutum gray with four brown stripes; scutum gray, each lobe with two brown areas; posterior sclerites of notum gray, with indications of a capillary dark line. Pleura light gray; dorsopleural region yellow. Halteres yellow, the knobs dark brown with the apices a little brightened. Legs with the coxæ light gray; trochanters yellow; femora yellow, the tips narrowly dark brown, the amount subequal on all legs; tibiæ yellow, the tips very narrowly darkened; tarsi passing into black. Wings (Plate 1, fig. 22) subhyaline, the stigma pale brown; a scarcely evident darker pattern, arranged much as in *obsoleta,* most evident as a weak seam in cell M adjoining vein Cu; veins brown. Venation: R_{1+2} entire; veins M_1 and M_2 divergent, cell M_1 ample; cell 1st M_2 with cephalic face convex; M_{3+4} short.

Abdominal tergites yellow to brownish yellow, more or less darkened sublaterally; in some cases, including type, only the outer segments are darkened. Male hypopygium (Plate 5, fig. 59) relatively small in size; basistyle incomplete, its caudal portion not narrowed or produced. Ninth tergite, 9*t*, with the caudal margin bearing a U-shaped notch. Outer dististyle moderately flattened. Inner dististyle, *id,* a simple compressed yellow blade, with a small acute subterminal beak. Eighth sternite, 8*s*, with the caudal margin gently convex, but without any conspicuous armature of lobes or setæ; median area narrowly membranous.

Habitat.—Eastern Siberia (Kamchatka).

Holotype, male, Osernaja Village, mouth of Osernaja River, 160° 30′ east longitude, 57° north latitude, September 13, 1909 (*Dershavin*), No. 387. Allotopotype, a broken female, Great Javinsky, source of Osernaja River, Lake Kurilskoje, September 19, 1909, No. 402. Paratopotypes, 2 males, with types, Nos. 388, 390.

In its general appearance, the present fly is very similar to the European *Tipula obsoleta* Meigen, but is very distinct in the structure of the male hypopygium, notably the simple inner dististyle and unproduced eighth sternite.

TIPULA FIDELIS sp. nov. Plate 1, fig. 23; Plate 5, figs. 60, 61.

Belongs to the *marmorata* group, allied to *productella;* general coloration gray, the præscutum with three brown stripes, the broad median one entire; antennæ unusually long for a member of the group, if bent backward extending about to base of abdomen; wings with the pattern nearly obsolete; male hypopygium with the basistyle produced into a slender flattened lobe; eighth sternite with the caudal margin subtransverse, without lobes or hair brushes, excepting a sparse median group of long yellow setæ.

Male.—Length, about 12 millimeters; wing, 14; antenna, about 5.

Frontal prolongation of head obscure yellow, nasus distinct; palpi light brown, the outer segments darker. Antennæ (male) longer than usual in the group; scape and pedicel yellow, flagellum brownish black; verticils shorter than the segments. Head brownish gray.

Mesonotal præscutum gray, with three brown stripes, the median one darker, broad and entire; brown areas of scutal lobes poorly defined. Pleura gray, the dorsopleural membrane pale yellow. Halteres yellow, the knobs dark brown. Legs with the coxæ yellow, very sparsely dusted; trochanters yellow; femora yellow, the tips narrowly brownish black; tibiae yellow, the tips very narrowly darkened; basitarsi yellow, the tips and remainder of tarsi black. Wings (Plate 1, fig. 23) grayish subhyaline, with the usual pattern almost obsolete; stigma brown; much paler brown clouds on anterior cord; vague whitish areas beyond stigma, before cord and as a spot in outer end of cell M; veins brown. Venation: Outer medial veins not conspicuously arched or arcuated, as is common elsewhere in the group; m-cu a short distance before fork of M_{3+4}.

Abdominal tergites yellow, trivittate with brown, the lateral margins narrowly pale; on intermediate and outer segments the amount of brown increases, the outermost segments darkened; basal sternites yellow, the outer segments darker. Male hypopygium (Plate 5, fig. 60) with the basistyle, *b*, produced into a flattened blade, as in *productella.* Ninth tergite (Plate 5, fig. 61, 9*t*) with obtuse lateral lobes, the median area of tergite membranous. Inner dististyle a broadly compressed darkened blade, subcircular in outline; ventrad of this lies a flattened yellow lobe, dilated outwardly, provided with numerous setæ, some from enlarged bases. Eighth sternite (Plate 5, fig. 60) without lobes on caudal margin, the membranous median

portion nearly transverse, with a sparse brush of long yellow setæ.

Habitat.—Eastern Siberia (Jakutsk).

Holotype, male, between Ajan and Nelkan, sources of Ignitjana River, August, 1903 (*Popoff*), No. 445.

Tipula fidelis is quite distinct from the other regional members of the *marmorata* group. The unusually long antennæ of the male, presence of only three præscutal stripes, and the conspicuously produced basistyle of the male hypopygium, all readily serve to distinguish this fly. The produced basistyle is much as it is in *T. productella* Alexander (Boreal North America), but the unmodified eighth sternite and the entire median præscutal stripe are very different.

TIPULA CUPIDA sp. nov. Plate 1, fig. 24; Plate 5, figs. 62, 63.

Belongs to the *marmorata* group, allied to *vafra* and *fragilina;* male hypopygium large, the lateral angles of ninth tergite extended laterad and ventrad into slender blackened points; eighth sternite large, the caudal portion bilobed by a deep incision, the lobes conspicuously setiferous.

Male.—Length, 10.5 to 11.5 millimeters; wing, 12.5 to 13.

Frontal prolongation of head brown; nasus distinct; palpi brownish black. Antennæ with scape and pedicel yellow, flagellum black. Head light gray.

Mesonotal præscutum gray, with four brown stripes, the anterior ends of the intermediate pair suffused with gray; posterior sclerites of notum gray, each lobe of scutum conspicuously variegated with dark brown. Pleura light gray, variegated with darker gray. Legs with the coxæ light gray; trochanters yellow; femora yellow, the tips narrowly infuscated; tibiæ obscure yellow, the tips very narrowly darkened; tarsi passing into brownish black. Wings (Plate 1, fig. 24) pale brown, variegated with darker brown and white areas, the pattern arranged as in the group; stigma, a confluent seam on anterior cord, a seam along vein Cu, and a cloud at apex of latter darker brown; two slightly less intense brown areas in cell M adjoining vein Cu; the whitish areas lie before and beyond stigma, in base of cell 1st M_2, at near midlength of cell M, and in cells Cu and 1st A; veins brown. Venation: Outer medial elements conspicuously arcuated, as common in the group.

Abdomen brown, the outer segments darker brown, the caudal margins of the segments ringed with pale. Male hypopygium (Plate 5, fig. 62) relatively large and conspicuous. Ninth ter-

gite, 9*t*, with a broad V-shaped notch, the lateral angles extended laterad and ventrad into slender blackened points. Outer dististyle, *od*, with the blackened area at base less spinous than in *vafra*. Inner dististyle (Plate 5, fig. 63, *id*) flattened, the extreme apex of beak minutely bifid. Eighth sternite, 8*s*, large and sheathing, the margin with two stout lobes that are clothed with long conspicuous setæ. Gonapophyses appearing as slender, delicately setiferous blades that gradually narrow to tips.

Habitat.—Eastern Siberia (Kamchatka).

Holotype, male, foot of Volcano Shiveluch, 162° 30′ east longitude, 56° 40′ north latitude, August 20, 1909 (*Protopopoff*), No. 420. Paratype, male, Lake Kurilskoje, September 28, 1909 (*Dershavin*), No. 405. Expedition Rjabushinsky Brothers.

The present fly is very closely allied to *T. vafra* Riedel (northern Europe) and somewhat more distantly to *T. fragilina* Alexander (northwestern North America), differing chiefly in slight features of the male hypopygium. *Tipula vafra* is somewhat larger, with a paler wing pattern; basal flange of outer dististyle produced into a distinct blackened tooth; inner dististyle with the blade wider, the apical beak slightly longer; lobes of eighth sternite shorter and wider, appearing more flattened.

TIPULA GYNAPTERA Alexander.

Tipula gynaptera ALEXANDER, Journ. New York Ent. Soc. 24 (1918) 72–73.

The unique type, a female, was collected at Plover Bay, northeastern Siberia, July 11, 1899, by Dr. William H. Dall. A number of additional specimens from this same general region are now available and further comparisons with the nearest described ally, *Tipula whitneyi* Alexander (Pribilof Islands) may be made.

The comparisons made at the time of original definition, of larger and more protuberant eyes and somewhat more elongate antennæ in the female of *whitneyi*, hold in the present series and moreover apply to the male sex as well. The longer, more stenopterous wings of the male of the present fly are likewise conspicuously different from the wings of *whitneyi*.

Fifteen additional specimens from Unden and Markovo, Chuckchi-land, Gulf of Anadyr, 175° 30′ east longitude, 64° 30′ north latitude, collected in 1898 by Gondatti. One of these is described herewith as allotype.

Allotype, male, length, 11 to 12 millimeters; wing, 4 to 5.

Antennæ black throughout; flagellar segments short, strongly constricted at near midlength. Præscutum with a median dark

gray stripe that is narrowly bordered behind by more brownish, gray, the lateral stripes obsolete or nearly so. Wings reduced, stenopterous, exceeding twice the length of the halteres and much longer than the antennæ. Male hypopygium without a median tooth at base of tergal notch. Inner dististyle with the lower lobe very broad.

Allotype, male, Anadyr Region, Chuckchi-land (*Gondatti*), No. 573.

In some of the other specimens, the pedicel of the antenna is obscure yellow.

These two flies, *gynaptera* and *whitneyi*, with the wings greatly reduced in both sexes, belong to what I had earlier called the *cineracea* group, including, besides the above, five species that are fully winged in both sexes: *T. cineracea* Coquillett, *T. crawfordi* Alexander, *T. katmaiensis* Alexander, *T. kirbyana* Alexander, and *T. malaisei* Alexander, all species occurring in Boreal North America and Asia, on both sides of Bering Straits, including Alaska, Wrangel Island, and Kamchatka. All members of the group agree in their small size, conspicuous lack of a nasus, simple male hypopygium, and other characters. The only species with evidently patterned wings is *crawfordi*. The hypopygia of the various species do not appear to present many characters, the relative length of the antennæ and the degree of constriction of the flagellar segments appearing more satisfactory.

TIPULA BLASTOPTERA sp. nov. Plate 5, fig. 64.

Female with wings greatly reduced in size; general coloration brown, the præscutum depressed; frontal prolongation of head short and stout, in alignment with the anterior vertex; antennæ 12-segmented, the outer segments short and crowded; abdomen black, the valves of ovipositor elongate, smooth.

Female.—Length, about 8.5 millimeters; wing, 0.7; antenna, 1.3.

Frontal prolongation of head brownish gray, short and stout, almost as in *Nephrotoma*, the prolongation in alignment with the anterior vertex; nasus short and stout; palpi brownish black. Antennæ (Plate 5, fig. 64) short, subequal in length to head (including prolongation); scape dark brown, pedicel obscure yellow; basal flagellar segments brighter brown than the outer ones; antennæ 12-segmented, the outer four flagellar segments short and crowded; basal flagellar segments short-cylindrical, the verticils exceeding the segments. Head brownish gray.

Mesonotum dark grayish brown, without distinct stripes; præscutal interspaces indicated by small yellow setæ; præscutum depressed, scutellum large. Pleura light brown. Halteres pale, reduced in size, bent, knobs poorly developed, darkened. Wings reduced to short scales that are about as long as the fore coxæ and much shorter than antennæ; wing venation reduced, the outer radial veins best indicated by rows of strong trichia; costal trichia reduced to two or three on basal half.

Abdomen chiefly black, the caudal margins of the intermediate segments very narrowly brightened. Ovipositor with the shield chestnut black; all valves elongate, with smooth margins.

Habitat.—Eastern Siberia (Ussuri).

Holotype, female, Sitza Station, Suchan District, June 15, 1927 (*Stackelberg*), No. 738.

In the female sex, the great reduction of the wings should make the identification of this species a very simple matter. No regional species of *Tipula* is known to me in the male sex that could possibly be associated with the present fly. The short frontal prolongation of the head is much as in *Nephrotoma*. It may be fairly assumed that this region of the body would be similar in the male and, if so, the alignment of the prolongation with the remainder of the front and the anterior vertex would be very characteristic, reminding one of certain Australian Tipulinæ, allied to *Clytocosmus* Skuse. European species of *Tipula* with the wings of the female greatly reduced include *T. autumnalis* Loew, *T. carinifrons* Holmgren, *T. gimmerthali* Lackschewitz, *T. pagana* Meigen, and two species of the subgenus *Vestiplex* Bezzi, [*T.* (*V.*) *cisalpina* Riedel and *T.* (*V.*) *hemapterandra* Bezzi], in all of which the wings, although reduced, are very much larger than in the present fly and show the venation clearly but distorted. Those species with greatest wing reduction (*autumnalis, gimmerthali, pagana*) are characteristic autumnal species, while the present fly is adult in spring.

ILLUSTRATIONS

[Legend: *a*, Ædeagus; *b*, basistyle; *d*, dististyle; *g*, gonapophysis; *id*, inner dististyle; *o*, cercus of ovipositor; *od*, outer dististyle; *p*, phallosome; *s*, sternite; *t*, tergite.]

PLATE 1

FIG. 1. *Tipula* (*Vestiplex*) *excisoides* sp. nov., venation.
2. *Tipula* (*Vestiplex*) *kamchatkana* sp. nov., venation.
3. *Tipula* (*Vestiplex*) *pallitergata* sp. nov., venation.
4. *Tipula* (*Vestiplex*) *immunda* sp. nov., venation.
5. *Tipula* (*Vestiplex*) *transbaikalica* sp. nov., venation.
6. *Tipula* (*Vestiplex*) *tchukchi* sp. nov., venation.
7. *Tipula* (*Arctotipula*) *hirtitergata* sp. nov., venation.
8. *Tipula* (*Arctotipula*) *gavronskii* sp. nov., venation.
9. *Tipula* (*Arctotipula*) *popoffi* sp. nov., venation.
10. *Tipula* (*Arctotipula*) *tundrensis* sp. nov., venation.
11. *Tipula* (*Lunatipula*) *polypogon* sp. nov., venation.
12. *Tipula* (*Lunatipula*) *lamentaria* sp. nov., venation.
13. *Tipula* (*Lunatipula*) *lundströmiana* sp. nov., venation
14. *Tipula* (*Lunatipula*) *flaccida* sp. nov., venation.
15. *Tipula* (*Lunatipula*) *dershavini* sp. nov., venation.
16. *Tipula* (*Lunatipula*) *lætibasis* sp. nov., venation.
17. *Tipula* (*Lunatipula*) *gondattii* sp. nov., venation.
18. *Tipula* (*Lunatipula*) *derbecki* sp. nov., venation.
19. *Tipula* (*Lunatipula*) *chernavini* sp. nov., venation.
20. *Tipula* (*Lunatipula*) *mesacantha* sp. nov., venation.
21. *Tipula mediolobata* sp. nov., venation.
22. *Tipula docilis* sp. nov., venation.
23. *Tipula fidelis* sp. nov., venation.
24. *Tipula cupida* sp. nov., venation.

PLATE 2

FIG. 25. *Tipula* (*Vestiplex*) *excisoides* sp. nov., male hypopygium, details.
26. *Tipula* (*Vestiplex*) *excisa* Schummel, male hypopygium, details.
27. *Tipula* (*Vestiplex*) *kamchatkana* sp. nov., male hypopygium, details.
28. *Tipula* (*Vestiplex*) *pallitergata* sp. nov., male hypopygium, details.
29. *Tipula* (*Vestiplex*) *immunda* sp. nov., male hypopygium, details.
30. *Tipula* (*Vestiplex*) *transbaikalica* sp. nov., male hypopygium, details.
31. *Tipula* (*Vestiplex*) *subcentralis* Alexander, male hypopygium, details.
32. *Tipula* (*Vestiplex*) *tchukchi* sp. nov., male hypopygium, details.
33. *Tipula* (*Vestiplex*) *tchukchi* sp. nov., male hypopygium, details.

PLATE 3

FIG. 34. *Tipula* (*Arctotipula*) *hirtitergata* sp. nov., male hypopygium, details.
35. *Tipula* (*Arctotipula*) *gavronskii* sp. nov., ovipositor.
36. *Tipula* (*Arctotipula*) *popoffi* sp. nov., ovipositor.
37. *Tipula* (*Arctotipula*) *tundrensis* sp. nov., male hypopygium, details.
38. *Tipula* (*Arctotipula*) *tundrensis* sp. nov., male hypopygium, detail.
39. *Tipula* (*Lunatipula*) *polypogon* sp. nov., male hypopygium, details.
40. *Tipula* (*Lunatipula*) *polypogon* sp. nov., male hypopygium, details.
41. *Tipula* (*Lunatipula*) *lamentaria* sp. nov., male hypopygium, details.
42. *Tipula* (*Lunatipula*) *lamentaria* sp. nov., male hypopygium, details.

PLATE 4

FIG. 43. *Tipula* (*Lunatipula*) *lundströmiana* sp. nov., antenna, male, segments three to six.
44. *Tipula* (*Lunatipula*) *lundströmiana* sp. nov., male hypopygium, details.
45. *Tipula* (*Lunatipula*) *lundströmiana* sp. nov., male hypopygium, details.
46. *Tipula* (*Lunatipula*) *flaccida* sp. nov., antenna, male, segments three to six.
47. *Tipula* (*Lunatipula*) *flaccida* sp. nov., male hypopygium, details.
48. *Tipula* (*Lunatipula*) *flaccida* sp. nov., male hypopygium, details.
49. *Tipula* (*Lunatipula*) *dershavini* sp. nov., male hypopygium, details.
50. *Tipula* (*Lunatipula*) *lætibasis* sp. nov., male hypopygium, details.
51. *Tipula* (*Lunatipula*) *sachalinensis* Alexander, male hypopygium, details.
52. *Tipula* (*Lunatipula*) *gondattii* sp. nov., male hypopygium, details.
53. *Tipula* (*Lunatipula*) *gondattii* sp. nov., male hypopygium, details.

PLATE 5

FIG. 54. *Tipula* (*Lunatipula*) *derbecki* sp. nov., male hypopygium details.
55. *Tipula* (*Lunatipula*) *mesacantha* sp. nov., male hypopygium, details.
56. *Tipula* (*Lunatipula*) *mesacantha* sp. nov., male hypopygium, details.
57. *Tipula mediolobata* sp. nov., male hypopygium, details.
58. *Tipula luteipennis* Meigen, male hypopygium, details.
59. *Tipula docilis* sp. nov., male hypopygium, details.
60. *Tipula fidelis* sp. nov., male hypopygium, details.
61. *Tipula fidelis* sp. nov., male hypopygium, details.
62. *Tipula cupida* sp. nov., male hypopygium, details.
63. *Tipula cupida* sp. nov., male hypopygium, details.
64. *Tipula blastoptera* sp. nov., antenna, female.

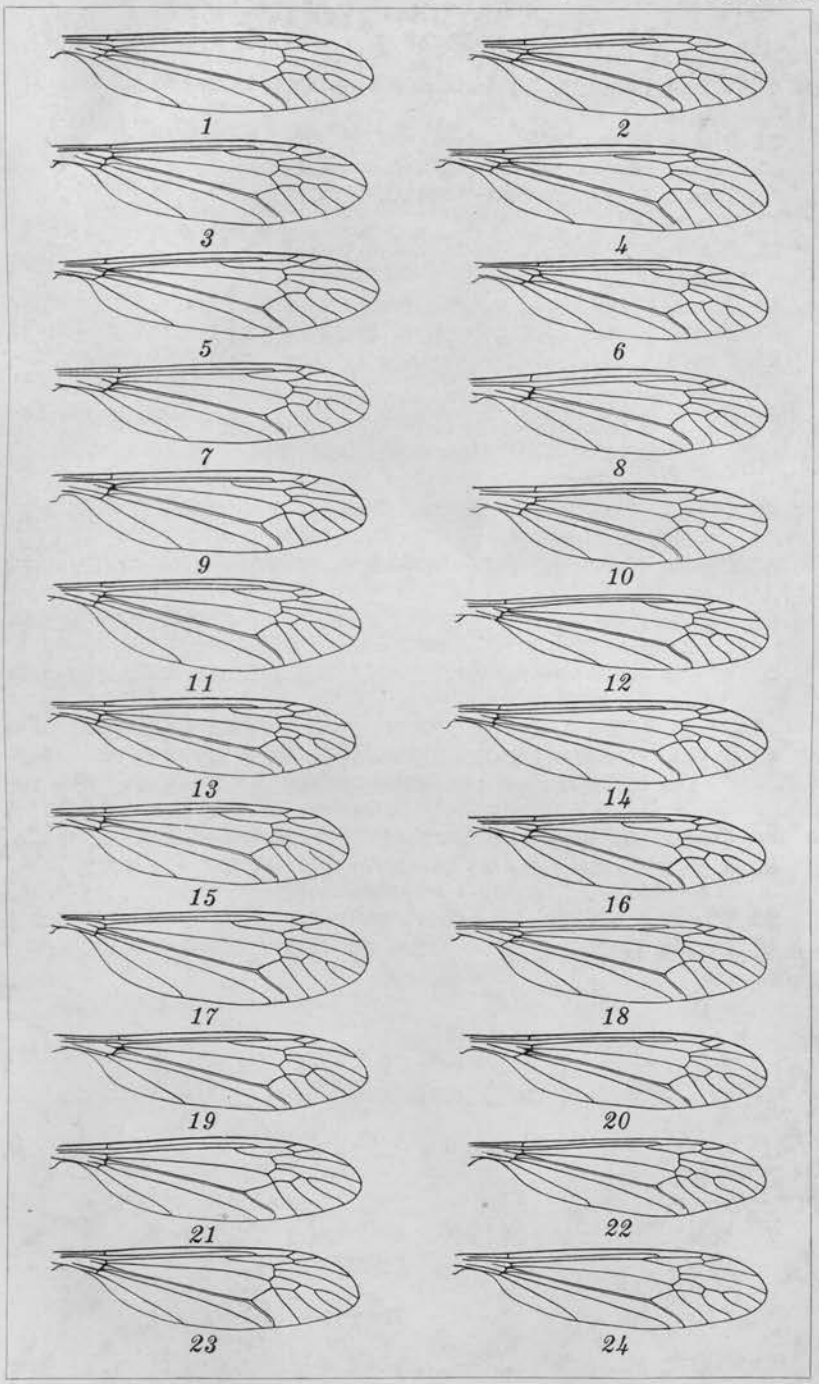

PLATE 1.

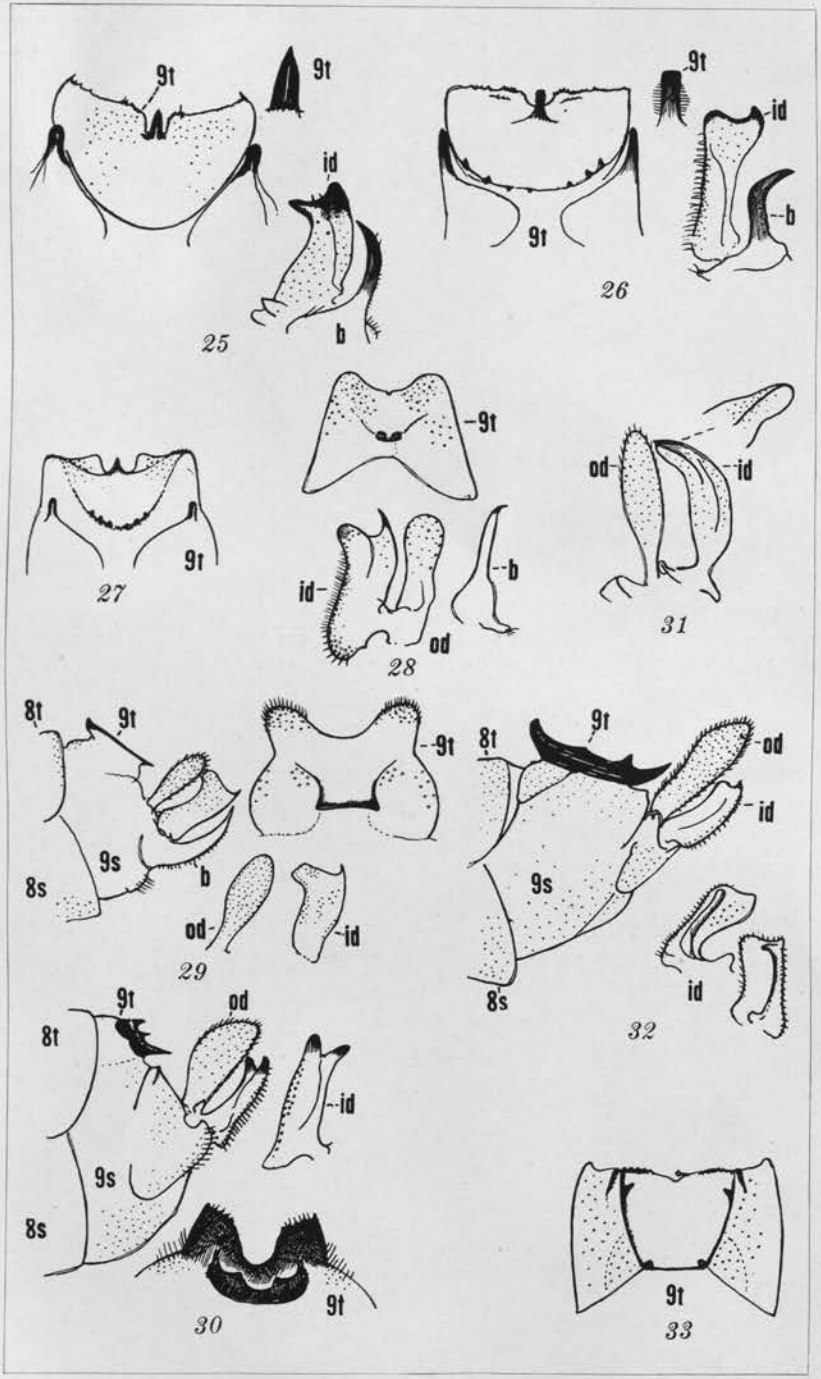
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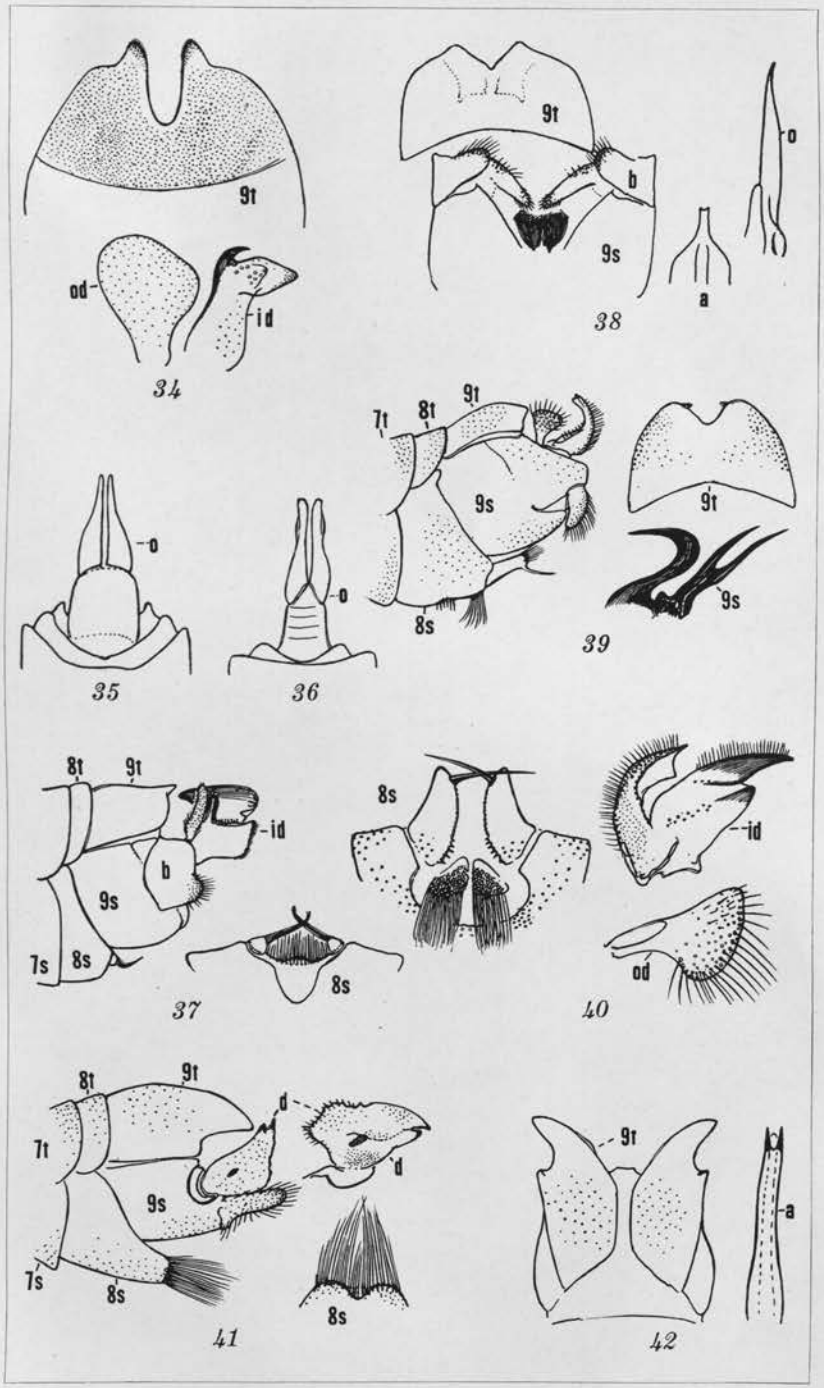
PLATE 2.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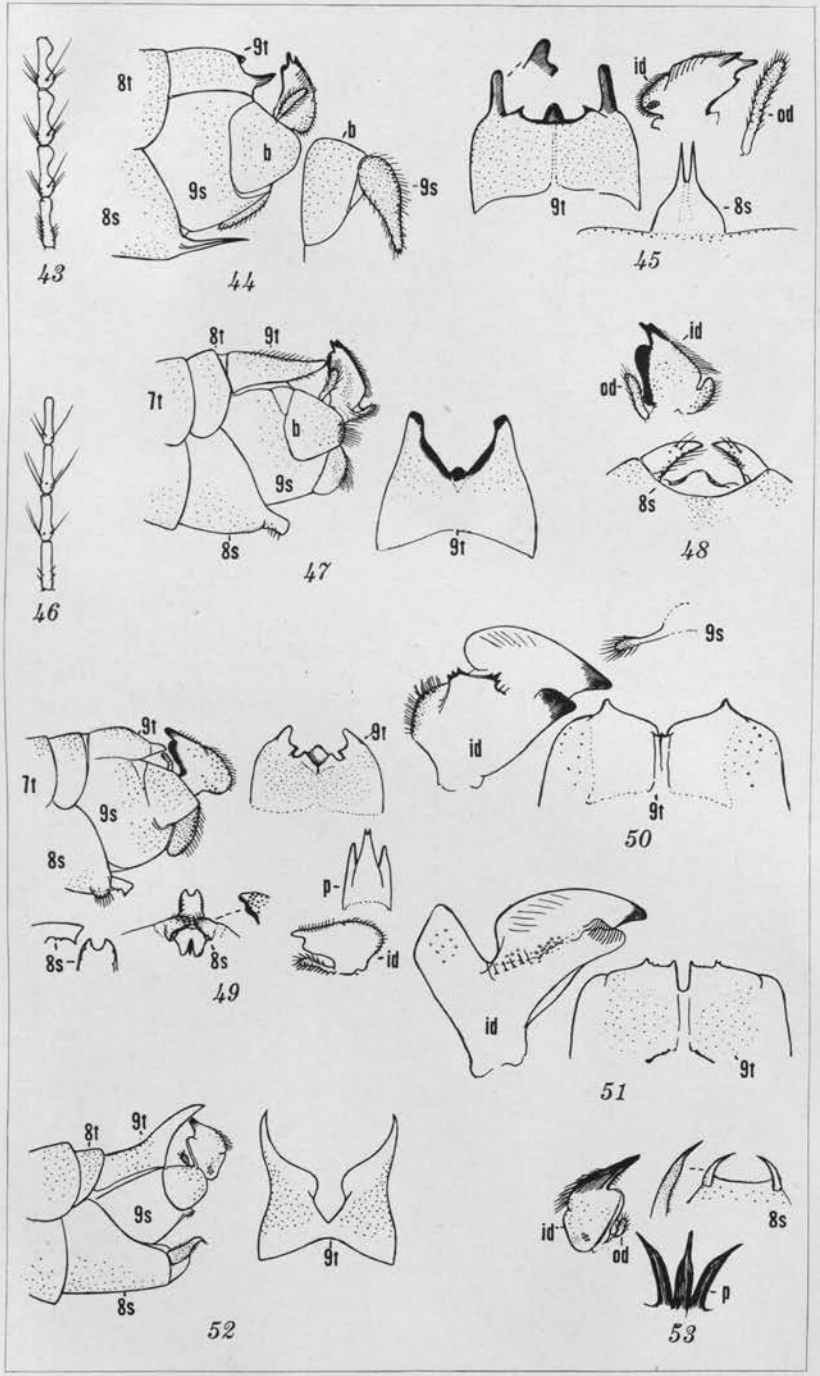
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PLATE 4.

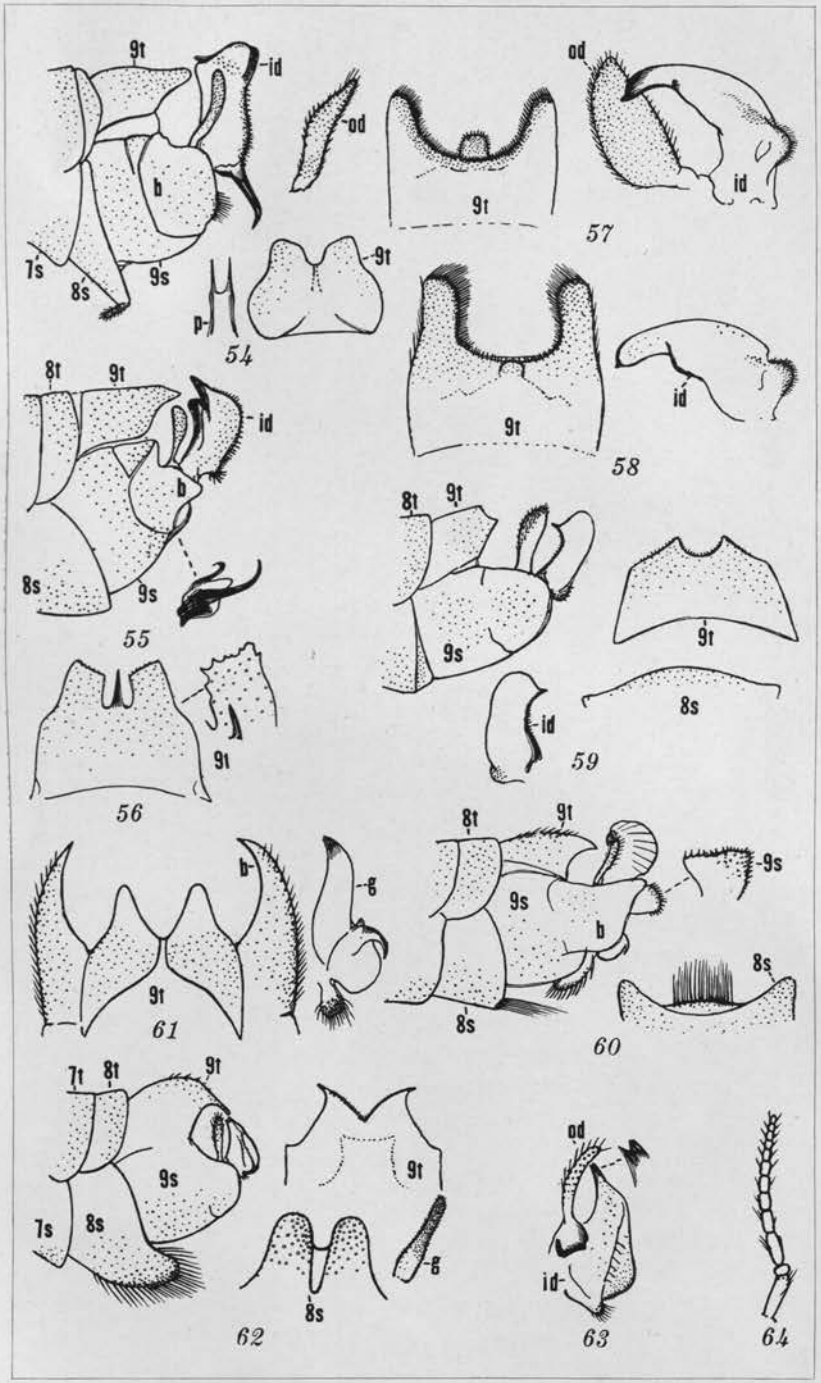
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PLATE 5.

NEW OR NOTEWORTHY PHILIPPINE ORCHIDS, IV

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and

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SEVENTEEN PLATES

The present contribution is essentially similar to its predecessors.[1] It consists of descriptions of five new species and four new varieties. One previously described species, *Cymbidium dayanum*, is for the first time credited to the Archipelago. *Phalaenopsis Micholitzii, Aërides Jarckianum, Aërides quinquevulnerum* var. *album*, and *Phalaenopsis equestris* var. *leucotanthe*, which were known only from their original descriptions, were recently rediscovered. A few combinations and changes in nomenclature are hereby proposed; this is particularly true with the species belonging formerly to *Trichoglottis* which we now propose to transfer to *Stauropsis*. *Sarcochilus unguiculatus*, which was interpreted as a synonym of *S. pallidus*, is hereby validated and elevated once more to a specific rank. All the descriptions in the text have been prepared from living specimens, and all the illustrations were made by Messrs. F. Guerrero and J. M. Salazar, draftsmen of the National Museum Division, Bureau of Science. All the types of the new species and varieties have been deposited in the herbarium of the Bureau of Science, with the isotypes in the herbarium of the senior author. Available isotypes will be distributed to the herbarium of the New York Botanical Garden and to other herbaria.

Genus DENDROBIUM Swartz

DENDROBIUM ALICIAE sp. nov. Plate 1, figs. 1 and 2; Plate 4, figs. 1 to 9; Plate 8, fig. 1.

Aff. *Dendrobio acuminatissimo*. Caules numerosi, simplices, fasciculati, penduli, 98 ad 107 cm longi, 2 ad 2.5 mm in crassi-

[1] Philip. Journ. Sci. 44 (1931) 369–383, 16 pls.; 47 (1932) 197–220, 29 pls.; 49 (1932) 483–504, 28 pls.

tudine, nitidi, teretes; internodia 1.5 ad 3.5 cm longa. Folia linearia, longe angustata, apice valde inaequalia, 9.5 ad 11.5 cm longa, 5 ad 5.5 mm lata, papyracea, vaginae foliorum arctae, glabrae. Racemi biflori; rhachis brevissima; pedunculus 1.3 ad 1.8 cm longus; bracteae oblongae, 7 ad 10 mm longae. Flores fugaces, caduci. Sepala lineari-lanceolata, in caudas longas filiformes tenerrimas extensa 3 ad 6 cm longa, basi 3.5 ad 5 mm lata; mentum sepalorum lateralium breve, obtusum, 4 ad 5.5 mm longum. Petala aequalia, 3 ad 5 cm longa, basi 2.5 ad 3 mm lata. Labellum manifeste trilobum, 10 ad 11 mm longum; lobi laterales oblique ovato-triangulares, obtusi, parte libera 2.25 ad 2.5 mm longa; lobus intermedius multo major, ovato-oblongus, 6 ad 7 mm longus, 2.5 ad 3 mm latus, supra conspicue densissime pilosus; discus per dimidium basale cum linea mediana incrassata. Gynostemium breve, circiter 4 mm longum; stelidia brevia, rotundata, levissime denticulata.

Stems numerous, simple, fascicled, pendulous, 98 to 107 cm long, 2 to 3.5 mm in diameter, smooth, terete; internodes 1.5 to 3.5 cm long. Leaves linear, narrowed to the tips, the apex unequal, 9.5 to 11.5 cm long, 5 to 5.5 mm wide, papery, the sheaths glabrous. Racemes two-flowered, rachis very short, the peduncles 1.3 to 1.8 cm long; bracts oblong, 7 to 10 mm long. Flowers fugaceous, ephemeral. Sepals linear-lanceolate, with very long slender prolongations, 3 to 6 cm long, 3.5 to 5 mm wide at the base; the mentum short, obtuse, 4 to 5.5 mm long. Petals similar to the sepals in form, 3 to 5 cm long, 2.5 to 3 mm wide. Labellum manifestly trilobed, 10 to 11 mm long; lateral lobes (free portion) obliquely ovate-triangular, obtuse, 2.25 to 2.5 mm long, covered with short papillose hairs; middle lobe much larger, ovate-oblong, 6 to 7 mm long, 2.5 to 3 mm wide, the upper surface densely and conspicuously pilose. Disc through the basal half with a very prominent central fleshy ridge. Column short, about 4 mm long, stelidia short, rounded, obscurely denticulate.

LUZON, Benguet Subprovince, Baguio, *Bur. Sci. 84618 Eduardo Quisumbing*, May 9, 1932. The type material was originally collected by Mrs. K. B. Day from Mount Santo Tomas, near Baguio. Living plants are now under cultivation in the gardens of Mrs. K. B. Day and Mrs. Colton in Baguio, and Mrs. Remedios C. Gonzales in Manila.

Sepals and petals are straw yellow [2] and spotted with carmine or oxblood red; the middle lobe of the labellum is empire yellow, covered on the upper surface with numerous white hairs, the lateral lobes are white and spotted with oxblood red.

The alliance of this species is doubtless with *Dendrobium acuminatissimum* (Blume) Lindl. which had been found but twice in the Philippines. It differs, however, conspicuously in the size and color of the flowers, and in the details of the labellum.

This species is dedicated to Mrs. K. B. Day who has graciously and kindly coöperated with the junior author in giving him free access to her collections of living orchids and is a testimonial to her interest in Philippine orchids.

DENDROBIUM PLICATILE Lindl. var. CONVOCARII var. nov. Plate 1, figs. 5 ahd 6; Plate 4, figs. 10 to 19; Plate 8, fig. 2.

Aff. *D. plicatili.* Caules 35 ad 65 cm longi, ramosi. Pseudobulbi parvi, monophylli. Folia sessilia, elliptica vel oblongo-elliptica, obtusa, 4 ad 6.5 cm longa, 2.5 ad 3 cm lata. Flores odoratissimi, singuli, fugacei, parvi, 2.8 ad 3 cm lati. Sepala oblongo-lanceolata, subacuta, 1.7 ad 1.9 cm longa, 6 ad 6.25 mm lata, mentum conicum, obtusum, circiter 5 mm longum formantia. Petala anguste oblonga, subacuta, 1.4 ad 1.5 cm longa, 3 and 3.5 mm lata. Labellum 1.6 ad 1.9 cm longum, basi cuneata; lobi laterales oblique triangulari-ovati, apice rotundati, parte libera 3 ad 4 mm longa, lobus intermedius subquadrato-flabellatus, retusus, margine valde undulato et lobulato; carinae usque supra medium 3, cum mediana obscura, deinde elevatulae et undulatae. Gynostemium brevissimum.

Rhizomes creeping, 6 to 8 mm in diameter. Stems rigid, suberect, smooth, shining and polished, jointed, 35 to 65 cm long, 4 to 6 mm in diameter, branching. Pseudobulbs monophyllous, shining; the leaflets ones usually ellipsoid or fusiform, up to 6 cm long; the leaf-bearing ones smaller, narrowly oblong-cylindric or oblong-obconic, 1.5 to 2.5 cm long. Leaves terminal, sessile, solitary, elliptic or oblong-elliptic, obtuse, 4 to 6.5 cm long, 2.5 to 3 cm wide. Flowers fragrant, solitary, axillary at the summit of apical pseudobulbs or at nodes at the apex of very short slender branches above the pseudobulbs, fugaceous,

[2] The color terms used are mostly from Ridgway's Color Standards and Color Nomenclature (1912).

2.8 to 3 cm across. Sepals oblong-lanceolate, subacute, 1.7 to 1.9 cm long, 6 to 6.25 cm wide, lateral ones oblique, forming a conical obtuse straight spur about 5 mm long. Labellum 3-lobed, 1.6 to 1.9 cm long, the base cuneate, decurved about in the middle; lateral lobes obliquely triangular-ovate, rounded at the apex, the free portion 3 to 4 mm long; middle lobe about 10 mm long, 14 mm wide, subquadrate-flabelliform, apex retuse; carinae 3, the middle line extending from the base of the labellum to the apex, the lateral ones prominently elevated and crisped in the middle particularly at the isthmus, the keels 1 to 1.5 mm high. Column very short.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 84713 Eduardo Quisumbing,* September 8, 1931.

The living plants were originally collected by Messrs. Maximo Ramos and Pascual Convocar in Dinagat Island, Surigao Province, Mindanao, on medium-sized trees near the seashore, in June, 1931, but now grow on adobe stone walls in the Bureau of Science orchid house.

Petals, lip, and column white, spotted with violet-carmine. Sepals white, suffused with massicot yellow at the base and spotted with violet-carmine. Spur massicot yellow and minutely dotted with pomegranate purple.

This form is apparently distinguished from the variable *Dendrobium plicatile* Lindl. by the smaller leaves, pseudobulbs, and flowers and by the lack of an elongate base of the lip. This variety is dedicated to Mr. Pascual Convocar, a botanical collector of the Bureau of Science, who discovered these plants perched on a tree.

DENDROBIUM IRAYENSE sp. nov. Plate 3, figs. 5 and 6; Plate 4, figs. 20 to 28; Plate 9, fig. 1.

Caules fasciculati, simplices, 30 ad 95 cm longi, penduli, multiarticulati, teretes; internodia 1.5 ad 3 cm longa, fibris vaginarum dejectarum vestita; nodi incrassati. Folia linearilanceolata, acuminata, acuta, submembranacea, 7.5 ad 9 cm longa, 1.4 to 1.6 cm lata; vaginae foliorum subcompressae, apice paulum ringentes. Racemi abbreviati, laxe 4- ad 8-flori, in caulibus defoliatis; bracteae sub anthesi scariosae, lanceolatae, acutae, 1.5 ad 2.5 mm longae. Flores purpurei, 1.4 ad 1.8 cm lati. Sepala lateralia ovata, acuta, 9 ad 10 mm longa, circiter 5.5 mm lata, 7-nervia, in mentum subaequilongum, obtusum producta. Sepalum dorsale erectum, ovato-lanceolatum, subacutum, 9 ad 9.5 mm longum, 4.5 ad 5 mm latum, 5-nervium. Petala lanceolato-elliptica, acuta, 8.5 ad 9.5 mm longa, 4 ad

4.5 mm lata, margine integra, 5-nervia. Labellum simplex, oblanceolatum, e basi sensim attenuatum, cucullatum, unguiculatum, subacutum, 13.5 ad 14 mm longum, callo basali hippocrepiformi. Columna brevis; clinandrium tridentatum, dentibus lateralibus rotundatis, dente medio tenui.

Stems fascicled, unbranched, 30 to 95 cm long, 8 to 15 mm in diameter, pendulous, terete, with swollen nodes; internodes 1.5 to 3 cm long. Leaves linear-lanceolate, acuminate, acute, submembranaceous, 7.5 to 9 cm long, 1.4 to 1.6 cm wide, the sheaths subcompressed. Racemes short, laxly 4- to 8-flowered, on defoliated stems. Flowers purple, 1.4 to 1.8 cm across, odorless; bracts pale purple, lanceolate, acute, 1.5 to 2.5 mm long. Pedicellate ovary slender, 10 to 14 mm long. Lateral sepals, ovate, acute, 9 to 10 mm long, about 5.5 mm wide at the base, 7-nerved; mentum subequally long, obtuse, retuse at the very tip. Dorsal sepal erect, ovate-lanceolate, subacute, 9 to 9.5 mm long, 4.5 to 5 mm wide, 5-nerved. Petals lanceolate-elliptic, acute, 8.5 to 9.5 mm long, 4 to 4.5 mm wide, the margins entire, 5-nerved. Labellum simple, oblanceolate, narrowed at the base, cucullate, unguiculate, subacute, 13.5 to 14 mm long, 5 to 5.5 mm wide near the apex, with a horseshoe-shaped callus at the base. Column short, about 2 mm long; stelidia erect, the lateral ones rounded, the median slender acute.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 84714 Quisumbing*, February 5, 1932.

The living plants were originally collected by the late Mr. Maximo Ramos, collector of the Bureau of Science, on Mount Iraya, Batan Island, north of Luzon.

The flowers are mallow purple or phlox purple, the nerves on sepals and petals and the lines on the labellum true purple; anther apricot yellow.

Dendrobium irayense is allied to *Dendrobium victoriae-reginae* Loher, but differs in its much smaller flowers and in the short lateral sepals.

DENDROBIUM YEAGERI sp. nov. Plate 3, figs. 7 and 8; Plate 4, figs. 29 to 37; Plate 9, fig. 2.

Caules fasciculati, 25 ad 50 cm longi, pauci ramosi, penduli; internodia ad basim leviter incrassata, 1.2 ad 2 cm longa. Folia lanceolata, acuta, 4.5 ad 10.5 cm longa, 1.3 ad 2.3 cm lata, nervosa, papyracea; vaginae foliorum subcompressae, apice paulum ringentes. Racemi pauciflori (2- ad 6-flori); bracteae oblongae, obtusae, usque ad 6 mm longae, membranaceae; ovarium pedicellatum tenerum, 1.5 ad 1.6 cm longum. Sepala la-

teralia lanceolato-oblonga, obtusa, circiter 1.9 cm longa, 7 ad 9 mm lata, 7-nervia, mentum obtusum, 9 ad 10 mm longum formantia. Sepalum dorsale oblongo-lanceolatum, subobtusum, 1.8 ad 1.9 cm longum, 7.5 ad 8 mm latum, 7-nervium. Petala anguste oblonga vel oblongo-elliptica, subobtusa, circiter 1.9 cm longa, 5.5 ad 7 mm lata, 5-nervia. Labellum simplex, oblanceolato-oblongum, e basi sensim dilatatum et antice expansum, apice rotundatum, 2.2 ad 2.5 cm longum, 9 ad 10 mm latum, lineae elevatulae nullae. Gynostemium perbreve, carnosum, circiter 5 mm longum, in pedem extensum; stelidia erecta, lateralia rotundata, stelidium medium acutum, 1 ad 1.25 mm longa. Capsula ellipsoidea, 2.4 ad 2.5 cm longa, 1.3 ad 1.4 cm in crassitudine. Flores basi purpureo-violacei, apice pallidiores.

Stems fascicled, slender, pendulous, 25 to 50 cm long; branches few, jointed, nodes greatly swollen, internodes 1.2 to 2 cm long. Leaves lanceolate, acute, 4.5 to 10.5 cm long, 1.3 to 2.3 cm wide, papyraceous and nervose when dried, leaf sheaths expanded above. Racemes few-flowered (2- to 6-flowered); bracts oblong, obtuse, up to 6 mm long, membranaceous. Flowers odorless, showy; pedicellate ovary slender, 1.5 to 1.6 cm long. Lateral sepals lanceolate-oblong, obtuse, about 1.9 cm long, 7 to 9 mm wide, 7-nerved, forming an obtuse mentum, 9 to 10 mm long. Dorsal sepal oblong-lanceolate, subobtuse, 1.8 to 1.9 cm long, 7.5 to 8 mm wide, 7-nerved. Petals narrowly oblong or oblong-elliptic, subobtuse, about 1.9 cm long, 5.5 to 7 mm wide, 5-nerved. Labellum simple, oblanceolate-oblong, gradually dilated from the base, expanded at the apex, broadly and bluntly apiculate, 2.2 to 2.5 cm long, 9 to 10 mm wide at the widest portion near the apex, devoid of any raised lines or calli. Column short, stout, about 5 mm long, extended into a foot; lateral arms erect, rounded, middle one narrow and acute, 1 to 1.25 mm long. Capsules ellipsoid, 2.4 to 2.5 cm long, 1.3 to 1.4 cm in diameter.

LUZON, Benguet Subprovince, Mount Pauai, *Bur. Sci. 85567 Eduardo Quisumbing*, May 9, 1932.

The living specimens were purchased from Igorot peddlers at Gate 52, Mountain Road, and were claimed to have originated in the hardwood forests of Mount Pauai.

The sepals and petals are pale lavender-violet or rose-purple at the tips, gradually increasing in intensity of color to the base which is Chinese violet or magenta, with the nerves of darker purple (Matthews' purple); labellum lavender-violet or pale rose-purple at the tip, darker at the base, bright violet-purple;

spur or mentum very bright violet-purple; pedicellate ovary aster purple; the column violet-purple, with white arms and anther.

Dendrobium Yeageri is closely allied to *Dendrobium victoriae-reginae* Loher, but may be readily separated by the reverse distribution of color in the flowers and the entirely smooth ecarinate lip.

This species is dedicated to Dr. C. H. Yeager, of the Rockefeller Foundation in Manila, who accompanied the junior author and Dr. W. H. Brown, former director of the Bureau of Science, on a trip to the Mountain Province in May, 1932.

Genus BULBOPHYLLUM Thouars

BULBOPHYLLUM SURIGAENSE sp. nov. Plate 1, figs. 3 and 4; Plate 5, figs. 1 to 9; Plate 10, figs. 1 and 2.

Radices fibratae, numerosae. Rhizoma repens. Pseudobulbi monophylli, cylindracei vel semifusiformes, 2.5 ad 3.2 cm longi, usque ad 5 cm distantia. Folia valde coriacea, rigida, ad apicem rotundata, ad basim attenuata, oblonga vel elliptico-oblonga, 5 ad 8.5 cm longa, 2 ad 2.8 cm lata, breviter petiolata. Scapus folio longior, 12 ad 14.5 cm longus; racemus recurvatus, 3 ad 3.5 cm longus, bracteis 5 vel 6 vaginantibus. Flores albidi, 2.5 ad 3.2 cm longi, in racemo perdenso dispositi. Bracteae inflorescentiae lineari-lanceolatae, acutae, cucullatae, 6 ad 10 mm longae. Pedicelli graciles. Sepala lateralia lanceolato-linearia, in apicem filiformem elongatum, obtusa, 5-nervia sensim extensa, primum connata, deinde libera, patentia, 3 ad 3.2 cm longa, glabra, prope basim ciliata. Sepalum dorsale ovatum, cucullatum, circiter 7 mm longum, 2.5 mm latum, 5-nervium, margine fimbriato. Petala triangulari-lanceolata, leviter falcata, acuminata, circiter 3.75 ad 4 mm longa, 3-nervia, margine fimbriato. Labellum minutum, anguste triangulare, acuminatum, acutum, recurvatum, ad basim cordatum, glabrum, 2.5 ad 3 mm longum, 1.5 mm latum, bilamellatum. Gynostemium brevissimum, ad apicem bicuspidatum, in pedem arcuatum extensum.

Roots numerous, fibrous, 0.75 to 1.25 mm in diameter. Rhizomes creeping, stout and woody. Pseudobulbs cylindrical or semifusiform, monophyllous, 2.5 to 3.2 cm long, strongly ridged, up to 5 cm apart, the young pseudobulbs clothed and almost covered with membranaceous, brown sheaths. Leaves oblong or elliptic-oblong, dark green, very leathery, firm and rigid, petiolate, bilobed at the rounded apex, cuneate at the base, 5

to 8.5 cm long, 2 to 2.8 cm wide; petioles 5 to 8 mm long. Scapes much longer than the leaves, 12 to 14.5 cm long including the erect peduncles; the racemes abbreviated, recurved or pendulous, 3 to 3.5 cm long. Sheaths infundibuliform, acute, 8 to 15 mm long, marguerite yellow with the tips greenish. Flowers odorless, crowded, 2.5 to 3.2 cm long. Pedicellate ovary very short, slender, greenish, 2 to 2.5 mm long. Floral bracts deep sea-foam green, linear-lanceolate, acute, cucullate, 6 to 10 mm long. Lateral sepals lanceolate-linear, with greatly elongated filiform tips, obtuse, 3 to 3.2 cm long, 5-nerved, white with marguerite yellow tips, minutely ciliate at the margins near the base, 5-nerved, at first connate, becoming free, parallel. Dorsal sepal ovate, acute, cucullate, about 7 mm long, 2.5 mm wide, 5-nerved, membranaceous, fimbriate on the margins. Petals narrowly triangular-lanceolate, slightly falcate, about 3.75 to 4 mm long, 1.25 mm wide at the base, ciliate on the margins, 3-nerved. Labellum minute, narrowly triangular, acuminate, acute, recurved, cordate at the base, glabrous, about 2.5 to 3 mm long, 1.5 mm wide, primuline yellow in color, with 2 ridges or keels running from the base to the tip. The column very short, white, about 1.5 mm long, bicuspidate at the apex, extended into an arcuate foot. Anther ovoid, obtuse, primuline yellow in color.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 84715 Eduardo Quisumbing*, September 11, 1931.

The living specimens were collected at Surigao, Surigao Province, Mindanao, by the botanical collectors, Messrs. Maximo Ramos and Pascual Convocar.

Among Philippine orchids, this species differs from *Bulbophyllum Loherianum* (Kränzl.) Ames in the much larger flowers and dissimilar lateral sepals and from *B. zamboangense* Ames in the awnless dorsal sepal and petals. It is vegetatively very similar to *B. medusae* Reichb. f.

Genus CYMBIDIUM Swartz

CYMBIDIUM DAYANUM Reichb. f. Plate 1, figs. 7 and 8; Plate 5, figs. 10 to 17; Plate 11, fig. 1.

Cymbidium dayanum REICHB. f. in Gard. Chron. (1869) 710: Williams' Orch. Grow. Man. ed. 7 (1894) 218; RIDL. Fl. Mal. Penin. 4 (1924) 146; Sanders' Orch. Guide (1927) 138.

Cymbidium acutum RIDL. in Journ. Linn. Soc. 32 (1896) 334; Mat. Fl. Mal. Penin. 1 (1907) 140; SCHLTR. Die Orchideen (1927) 355.

Cymbidium simonsianum KING and PRANTL. in Journ. As. Soc. Beng. 64, pt. 2 (1895) 338, in Ann. Roy. Bot. Gard. Calc. 8 (Orch. Sik.-Himal.) (1898) 188, *t. 250.*

The original description reads as follows:

Cymbidium Dayanum, sp. n.

Foliis longissimis (4 pedalibus), angustis (vix quartam pollicis latis) coriaceo-pergameneis apice nunc inaequali altero latere acutis, nunc aequaliter bidentatis, inferne suberosis; racemo plurifloro; vaginis scariosis acutis basi vaginato; rhachi angulata, bracteis triangulis acuminatis ovariis pedicellatis multo brevioribus, mento subevanido; flore carnosiusculo; sepalis linearibus acuminatis; petalis sublatioribus brevioribus, labello medio trifido, laciniis lateralibus semiovatis, acutangulis, lacinia media oblongo-triangula acuminata; carinis geminis parallelis approximatis velutinis, usque ad basin laciniarum lateralium altioribus, dein humilibus, ante apicem confluentibus.

Plant epiphytic, erect, stemless. Leaves 5 or 6, tufted, subcoriaceous, pale green, elongate linear, sessile, channelled at the base, acute and suboblique at the apex, 76.5 to 78.5 cm long, 1.1 to 1.4 cm wide. Racemes erect, about 24 cm long; peduncle about 11 cm long; sheaths at the base three or more, imbricated, 1 to 7 cm long, acute, pinkish vinaceous, the lowermost one nearly white. Pedicellate ovary 1.5 to 3 cm long. Flowers fragrant, about 10, 3.5 to 4.5 cm across; bracts triangular, acute, cucullate, 5 to 8 mm long. Lateral sepals spreading, elliptic-lanceolate or oblanceolate, acute and slightly subfalcate, 2.6 to 2.7 cm long, 7 to 8 mm wide. Dorsal sepal erect, elliptic-lanceolate or oblanceolate, acute, 2.8 to 2.9 cm long, 7 to 7.5 mm wide. Petals smaller than the sepals, connivent around the column, narrowly elliptic-oblong, acute, apiculate, 2.1 to 2.2 cm long, about 6 mm wide. Labellum 3-lobed, 2 to 2.2 cm long; lateral lobes broadly obtuse, free portion 3 to 3.5 mm long; middle lobe ovate, apiculate, reflexed, 7 to 7.5 mm wide; lamellae two, stout, parallel, conspicuously pubescent with white glandular hairs, ending abruptly with the lateral lobes, but continued to the middle lobe as raised lines. Column about 12 mm long. Anther broadly triangular-ovoid. Pollinia obliquely ovoid, compressed.

LUZON, Benguet Subprovince, Baguio, Mrs. K. B. Day's gardens, *Bur. Sci. 85569 Eduardo Quisumbing*, October 20, 1931. Living plants originally collected by Mrs. K. B. Day in Baguio, Mountain Province.

The flowers are fragrant, the sepals and petals are white with a crimson central line which does not extend to their apices, the labellum is Bordeaux with oblique white and seafoam yellow lines on the lateral lobes and an amber yellow. The column is blackish red-purple; the anther sulphur yellow. Pedicellate ovary lumiere green.

Sikkim, Assam, and Perak (Waterloo) at altitudes from 800 to 1,200 meters.

From the three species of *Cymbidium* known to occur in the Philippines, *Cymbidium dayanum* is distinguished by its grass-like, tufted leaves and the color of the flowers.

Genus SARCOCHILUS R. Brown

SARCOCHILUS UNGUICULATUS Lindl. Plate 2, figs. 9 and 10; Plate 5, figs. 18 to 24; Plate 12, fig. 1.

Sarcochilus unguiculatus LINDL. in Bot. Reg. 26 (1840) Misc. p. 67, 32 (1846) sub. *t. 19;* Edit. in Allg. Berl. Gartenz. 14 (1846) 167; REICHB. F. in Walp. Ann. 6 (1863) 501, in Gard. Chron. II 15 (1881) 562; NAVES Novis. App. (1882) 238; ROLFE in Orch. Rev. 2 (1894) 231, 14 (1906) 273, *fig. 37;* RIDL. in Journ. Linn. Soc. 31 (1896) 298, Mat. Fl. Mal. Penin. 1 (1907) 175; AMES in Merr. in Journ. Roy. Asiat. Soc. Straits Branch, Special No. (1921) 196, in Merr. Enum. Philip. Fl. Pl. 1 (1923) 408.

Thrixspermum unguiculatum REICHB. F. Xen. Orch. 2 (1867) 122, in Flora 51 (1868) 53; WARNER and WILL. Orch. Alb. 6 (1887) *t. 266;* MIETHE, Orchis 6 (1912) 101, 102, *t. 24.*

Phalaenopsis Ruckeri HORT. ex Reichb. f. in Gard. Chron. New Ser. 15 (1881) 562, in textu.

Phalaenopsis Ruckeriana HORT. ex Warner and Will. Orch. Alb. 6 (1887) *t. 266,* in syn.

Sarcochilus aureus HOOK. F., Fl. Brit. Ind. 6 (1890) 35, in Ann. Roy. Bot. Gard. Calc. 5 (Cent. Ind. Orch.) (1895) 42, *t. 64.*

Thrixspermum aureum O. KTZE., Rev. Gen. Pl. 2 (1891) 682.

Sarcochilus unguiculatus Lindl. var. *aureus* RIDL., Mat. Fl. Mal. Penin. (1907) 175.

? *Phalaenopsis fugax* KRÄNZL. in Gard. Chron. III 14 (1893) 360; ROLFE in Orch. Rev. 13 (1905) 230.

Sarcochilus unguiculatus; racemo 3-4-floro, labelli unguiculati trilobi ungue convexo lineari lineâ mediâ exaratâ, laminâ cavâ, lobis lateralibus semi-ovatis obtusis intermedio supra trinervi subtus globoso apice papillaeformi.

A native of Manilla, where it was discovered by Mr. Cuming. The flowers are light straw-color, the side lobes of the labellum white streaked with crimson, and the middle lobe rounded, fleshy, and dotted with crimson. It is a rather pretty species, for which I am indebted to Mr. Bateman.

Plants erect in habit. Stems very short. Leaves disposed more or less horizontally, distichous, 7 to 8 mm distant, oblong or elliptic-oblong, rigid, firm, coriaceous, greenish, the lower surface purplish, 10.5 to 16 cm long, 4 to 5.5 cm wide, unequally bilobed at the apex. Scapes very short, issuing from the side of the stems among the lower leaves, purplish, 2- to 4-flowered, 1 to 5.5 cm long. Flowers very fragrant, 2.3 to 2.5 cm across. Pedicellate ovary about 1.5 cm long, primrose

yellow. Lateral sepals oblong-elliptic, subacute, semioblique, slightly concave, 1.2 to 1.5 cm long, 4.5 to 5.5 mm wide, 5-nerved, colonial buff with a patch of eugenia red on the basal inner half and tipped with old rose. Dorsal sepal oblong-elliptic, subacute, cucullate, 1.2 to 1.5 cm long, 4.5 to 5.5 mm wide, 5-nerved, primrose yellow and tipped with pale rosolane purple. Petals narrowly oblong-elliptic, obtuse, 1.1 to 1.2 cm long, 4 to 4.5 mm wide, 3-nerved, primrose yellow lined in the middle with flesh pink. Labellum unguiculate, 3-lobed; claw convex, linear, median line smooth, eugenia red above, white below; lateral lobes semierect, oblong-ovate, rounded at the apex, about 4.5 mm long, 2 mm wide, naples yellow striped with eugenia red; middle lobe about 5 mm long, fleshy, white dotted with violet-purple, globose below, with a papilla above. Column cylindrical, about 4 mm long, marguerite yellow. Capsules oblong-cylindric, about 3 cm long, 1.2 cm in diameter, angled.

The original description of the species was based upon a specimen collected at Manila by Cuming, and according to Mr. Rolfe[3] the type plant flowered in the garden of Mr. Bateman in 1840. What is considered to be the same species was described as a *Phalaenopsis* (*P. fugax*), but the structure of the flower is far from being that of a *Phalaenopsis*.

LUZON, Manila, Mrs. Remedios C. Gonzales's gardens, *Bur. Sci. 85570 Eduardo Quisumbing,* July 11, 1932. Living specimens were said to have been collected in the mountains back of Antipolo, Rizal Province, Luzon.

This is the third time that *Sarcochilus unguiculatus* has come to the attention of the junior author during a period of four years, and while in the beginning he suspected that the species was separable from the true *S. pallidus* (Bl.) Reichb. f., additional data have convinced him of its distinctness. The flowers of *S. pallidus* last for a couple of hours only, opening early in the morning and generally wilting before noon, while records of the flowering of *S. unguiculatus* show that the flowers remain in good condition longer, opening the first day and wilting on the third day. It flowers from May to July.

Sarcochilus unguiculatus is distinct from *S. pallidus,* not only in the habit of the plant, but also in the following features. The leaves are disposed horizontally and are more rigid and tinged with purple on the lower surface. The racemes are decidedly shorter, the flowers are much smaller, the lateral

[3] Orch. Rev. 2 (1894) 231.

lobes of the labellum are oblong-ovate while the papilla on the front of the middle lobe is not so abrupt or prominent.

Genus PHALAENOPSIS Blume

PHALAENOPSIS EQUESTRIS (Schauer) Reichb. f. var. LEUCOTANTHE Reichb. f. Plate 2, figs. 7 and 8; Plate 11, fig. 2.

Phalaenopsis equestris (Schauer) Reichb. f. var. *leucotanthe* REICHB. F. in l'Orchidoph. 3 (1883) 490; AMES Orch. 2 (1908) 230, in Merr. Enum. Philip. Fl. Pl. 1 (1925) 414.

The original description reads as follows:

Les pétales et les sépales sont blanc aussi pur que la neige. Le labelle également blanc ponte quelques taches citron sur les lobes latéroux.

Habit is similar to the species. Leaves oblong, elliptic-oblong or oblanceolate-oblong, 9 to 11 cm long, 4 to 5 cm wide, light green in color. Scape about 20 cm long, ascending, unbranched. Flowers about 1.4 cm across; pedicellate ovary about 2 cm long. Sepals oblong-lanceolate or ovate-lanceolate, obtuse, about 1.4 cm long, 6 to 7 mm wide, the lateral ones asymmetric. Petals elliptic, obtuse, about 12.5 mm long, 7 mm wide. Labellum 3-lobed; lateral lobes linear-spatulate, about 7 mm long, 2.5 mm wide, incurved; middle lobe ovate, acute, about 12 mm long, 7 mm wide. Column about 8 mm long.

LUZON, Manila, Mrs. Remedios C. Gonzales's gardens, *Bur. Sci. 85571 Eduardo Quisumbing*, October 30, 1931. The living plants were collected in the mountains of Rizal Province, near Antipolo.

Peduncles chrysolite green. Buds chartreuse yellow. Sepals and petals pure white or white with very faint line of pale rose-purple at the center. Column white at the base, apex pale rose-purple. Lateral lobes of the labellum white with the base suffused with amber yellow or citron, the apex sometimes slightly suffused with pale rose-purple; middle lobe white with honey yellow at the base or white tipped with pale rose-purple. Callus at base of middle lobe empire yellow and dotted with red.

The variety differs from the species in the color of the peduncles, floral buds, and flowers.

PHALAENOPSIS MICHOLITZII Rolfe. Plate 2, figs. 1 and 2; Plate 5, figs. 25 to 33; Plate 12, fig. 2.

Phalaenopsis Micholitzii ROLFE in Gard. Chron. III 8 (1890) 187, in Journ. des Orch. 1 (1890) 198, in Orch. Rev. 13 (1905) 229; AMES Orch. 5 (1915) 217, in Merr. Enum. Philip. Fl. Pl. 1 (1925) 415.

Since *Phalaenopsis Micholitzii* has never been adequately described, the following amplification is given.

Herba *P. Lueddemannianae* habitu. Caulis abbreviatus, paucifoliatus. Folia oblongo-oblanceolata, ad basim sensim angustata, carnosa. Scapi breves, simplices, pauciflori. Flores subflavidi et sine maculis. Sepala lateralia oblique ovata, acuta. Sepalum dorsale oblongo-ellipticum, obtusum. Petala ovato-elliptica, breviter unguiculata. Labellum trilobatum; lobi laterales erecti, subquadrato-oblongi, apice bidentato truncato; lobus intermedius rhombico-spathulatus, inferne unguiculatus, apice obtuse tridentatus; discus supra medium papillis capilliformibus numerosis ornatus. Columna flavida.

Habit similar to that of *P. Lueddemanniana* Reichb. f. Stem abbreviated. Leaves oblong-oblanceolate, 13 to 17.5 cm long, 5.5 to 7 cm wide, broadly obtuse at the apex, gradually tapering to the base, pale green, fleshy, thick, very slightly rigid, somewhat conspicuously nerved with yellowish nerves. Scapes simple, short, few-flowered, 3 to 6 cm long, appearing in the axils of the leaves or at the base of the stem near the roots; rachis very short. Flowers odorless, 6 to 6.5 cm across, yellowish, and absolutely without transverse bars on the sepals and petals, 1 or 2 opening at a time. Pedicellate ovary marguerite yellow, about 3.3 cm long, the ovary terete, not twisted. Lateral sepals obliquely ovate, acute, apiculate, 3.2 to 3.3 cm long, 1.6 to 1.7 cm wide, 9-nerved. Dorsal sepal oblong-elliptic, obtuse, 3.2 to 3.3 cm long, 1.5 to 1.6 cm wide, 9-nerved. Petals ovate-elliptic, obtuse, about 2.8 cm long, 1.7 cm wide, with shortly stalked base which is about 4 mm long, 7-nerved. Labellum fleshy, 3-lobed; lateral lobes erect, subquadrate-oblong, with a prominent fleshy callus above the middle, bidentate at the truncate apex, about 8 mm long, cadmium yellow; middle lobe rhombic-spatulate, about 1.9 cm long, narrowed below into a distinct claw about 7 mm long, obtusely tridentate at the apex when spread out, the irregular margins minutely crisped-undulate, marguerite yellow; disc (between the side lobes) with a ligulate sharply bidentate callus which extends (in the middle of the claw) into a median high keel dentate in front, and which is succeeded by an irregular longitudinal cluster of hairlike papillæ. Column about 1.2 cm long, marguerite yellow; anther white.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 85572 Eduardo Quisumbing,* February 3, 1932.

A living plant of this species was sent to the junior author by Mr. F. E. Shafer, an orchid enthusiast of Cebu, who purchased it from a peddler in Cebu. Its origin is unknown, but is doubtless Philippine. The plant presented to the junior

author is still growing in the Bureau of Science orchid house, and has flowered twice already this year (February 3 and May 31, 1932), the flowers lasting about two weeks.

A species with the habit of *P. Lueddemanniana* Reichb. f., differing conspicuously in its yellowish flowers with absolutely no bars on the sepals and petals, and in the form of the middle lobe of the labellum.

Genus AËRIDES Loureiro

AËRIDES JARCKIANUM Schltr. Plate 3, figs. 1 and 2; Plate 6, figs. 1 to 8; Plate 13, fig. 1.

Aërides jarckianum SCHLTR. in Orchis 9 (1915) 53, *t. 5, figs. 15–21*; AMES in Merr. Enum. Philip. Fl. Pl. 1 (1925) 420; SUMMERHAYES in Bot. Mag. 155 (1932) *t. 9274*.

Aërides sp. SCHLTR. in Orchis 9 (1915) 29, in dos.

Aërides recurvipes J. J. SM. in Bull. Jard. Bot. Buitenz. III 8 (1926) 63.

The original description reads as follows:

Aërides Jarckianum Schltr. n. sp.

Planta epiphytica, habitu A. rubescenti (Rolfe) Schltr. similis cui affinis, c. 20 cm. alta; foliis loratis illis Rhynchostylidis retusa Bl. similibus, sed latioribus et minus carinatis; racemis leviter decurvis, dense multifloris, c. 25 cm. longis; cylindraceis; pedunculo c. 10 cm. longo; bracteis reflexis, ovatis subacutis, ovario multo brevioribus; floribus adscendentibus vel suberectis in racemo decurvo, glabris, roseis, illis A. rubescentis (Rolfe) Schltr. similibus, c. 1 cm. diametientibus; sepalo intermedio suborbiculari, apiculato, concavo, c. 5 mm. longo, lateralibus oblongis obtusis, c. 6 mm longis obliquis; petalis late et oblique ovalibus obtusis, sepalo intermedio paululo brevioribus; labello trilobo, c. 6 mm. longo, lobis lateralibus incurvis, oblique oblongis, obtusiusculis, intermedio antico incurvo, ligulato, apice obtuse tridentato, lateralibus plus duplo longiore calcare oblique conico, leviter arcuato-protuso, subacuto, c. 8 mm. longo, columna brevi generis, pede subduplo longiore incrassato, medio longitudinaliter foveolato, c. 3 mm. longo, ovario pedicellato subviscido, glabro, pedicello gracili incluso c. 1.7 cm. longo.

Stems curved or recurved, terete, 30 to 35 cm long. Leaves lorate, recurved, leathery, thinner than those of *Aërides quinquevulnerum* Lindl., 12 to 20 cm long, 2 to 3 cm wide, unequally bilobed at the apex, slightly carinate on the back. Racemes subpendulous, densely many-flowered, 10 to 15 cm long, with their peduncles 30 to 50 cm long; sheaths remote, tubular, ovate, obtuse, up to 13 mm long. Flowers odorless, 12 to 13 mm across, 18 to 19 mm long; bracts ovate, acute, reflexed, up to 6 mm long. Pedicellate ovary slender, 14 to 16 mm long. Lateral sepals convex, suborbicular, subtruncate or broadly rounded at the apex, about 7 mm long, 6 mm wide, 7-nerved. Dorsal

sepal suborbicular-oblong, about 7 mm long, 4.5 to 5 mm wide, 7-nerved. Petals oblong-suborbicular or oval, rounded, about 6.5 mm long, 4 to 4.5 mm wide, 7-nerved. Labellum fleshy, trilobed; lateral lobes incurved and overlapping, joined to the middle lobe, falcate-oblong, obtuse or obliquely truncate, denticulate at the apex, about 3 mm long, 2 mm wide, the side margins entire; middle lobe lanceolate, strongly incurved at the tip, base covered by the infolded lateral lobes, narrowed to the obtuse, apiculate apex, 5.5 to 6 mm long, about 3 mm wide at the base, the margins entire. Spur conical, somewhat incurved, obtuse, 9 to 10 mm long. Column erect, very short, fleshy, stout, extended in a long slightly convex foot, about 8 mm long including the foot which has two thickened ridges on each side. Anther broadly triangular, beaked.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 80815, 80836 Eduardo Quisumbing*, October, 1930.

Living plants were collected in the mountains of Rizal Province, by Novaliches orchid collectors, at medium altitudes.

Pedicellate ovary cameo pink to almost white; sepals and petals white dotted with light mallow pink; middle lobe of the labellum phlox purple to magenta; lateral lobes of the labellum phlox pink spotted with magenta; the spur magenta. Flowering season from December to February.

A species often mistaken locally for *Anota violacea* (Lindl.) Schltr. However, the two species are conspicuously differentiated by the floral parts. It differs from *Aërides quinquevulnerum* Lindl. in being a more slender plant, in the size and color of the flowers, and in the structure of the floral parts particularly the labellum. The species is allied to *Aërides Leeanum* Reichb. f., differing in the shape and details of the labellum.

AËRIDES JARCKIANUM Schltr. var. SMITHII var. nov. Plate 3, figs. 3 and 4; Plate 6, figs. 9 to 16; Plate 13, fig. 2.

A typo foliis latioribus sepalis lateralibus saepissimi truncatis et floribus paulo majoribus intensius coloratis differt.

Plant more robust than the species. Leaves 13 to 19 cm long, 3.5 to 4 cm wide, about 2 mm thick, more distichous, broader and more rigid than in the species. Racemes 11 to 19 cm long, with the peduncles 26 to 62 cm long. Flowers more intensely colored than in the species, flower parts not so spreading as in the species, about 10 mm across, 20 to 21 mm long. Pedicellate ovary mallow purple, 20 to 22 mm long. Lateral sepals bent forward, with the anterior margin slightly involute, subquadrate, truncate, about 7.5 mm long, 6.5 mm wide, 7-nerved.

Dorsal sepal strongly cucullate, subquadrate-oval, rounded, about 7 mm long, 6 mm wide, 7-nerved. Petals suborbicular, rounded, about 6 mm long, 5.5 mm wide, 5-nerved. Labellum 3-lobed; lateral lobes not overlapping completely as in the species but overlapping only by the anterior margins, broadly falcate-oblong, truncate, denticulate at the apex, about 7.5 mm long, 3.5 mm wide; middle lobe oblong, broadly obtuse at the apex, the very tip slightly incurved, about 7.5 mm long, 3.75 mm wide. Spur as in the species, about 11 mm long. Column stout, fleshy, about 8.5 mm long including the foot.

LUZON, Manila, Mrs. Remedios C. Gonzales's gardens, *Bur. Sci. 80816 Eduardo Quisumbing*, October 6, 1930.

The living plants were collected originally in the same locality as the species. Basal half of the lateral sepals light mallow pink, upper half magenta; spur, dorsal sepal, and petals magenta. Labellum magenta except the apical four-fifths of the lateral lobes which is cameo pink. Column white; anther naphthalene yellow.

The variety is chiefly distinguished from the species by its more robust stems, more distichous, thicker wider leaves, more intensely colored and larger flowers and truncate lateral sepals.

This interesting variety is dedicated to Dr. J. J. Smith, an indefatigable student of Indo-Malaysian orchids, particularly those of Sumatra and Java, who has helped us to identify the species. The determination was accidental while Doctor Smith was studying the true status of the so-called *Anota violacea* from the Philippines.

AERIDES QUINQUEVULNERUM Lindl. var. ALBUM Williams. Plate 2, figs. 3 and 4; Plate 6, figs. 17 to 25; Plate 14, fig. 1.

Aërides quinquevulnerum Lindl. var. *album* WILLIAMS in Orch. Grow. Man. ed. 2 (1862) 41.

Aërides quinquevulnerum Lindl. var. *Farmeri* WILLIAMS apud Stein Orchideenb. (1892) 63; WILLIAMS, Orch. Grower's Man. ed. 7 (1894) 90; AMES Orch. 2 (1908) 253, in Merr. Enum. Philip. Fl. Pl. 1 (1925) 422.

Aërides Farmeri BOXALL ex Naves Novis. App. (1882) 239, nomen.

Aërides album SANDER apud Stein Orchideenb. (1892) 63, in syn.

"A white variety of the preceding, (*A. quinquevulnerum*), producing long spikes of white flowers; grows like *quinquevulnerum*, and blooms about the same time." Ex Orch. Grower's Man. ed. 2 (1862) 41.

In habit similar to the species. Roots fleshy, greatly elongated, 5 to 9 mm in diameter. Stems unbranched, terete, 15 to 30 cm long, 1.2 to 1.3 cm in diameter. Leaves more distichous than in the species, carinate, coriaceous, 18 to 30 cm long, 3

to 4 cm wide. Racemes axillary, drooping, many-flowered, 20 to 30 cm long. Flowers very fragrant, pure white, fleshy and waxy, about 20 mm across. Pedicellate ovary 13 to 15 mm long. Sepals and petals spreading. Lateral sepals suborbicular-ovate, rounded at the apex, 10 to 11 mm long, 7 to 8 mm wide 7-nerved. Dorsal sepal suborbicular-oval, broadly obtuse, 7.5 to 9 mm long, about 7 mm wide, 5-nerved. Petals suborbicular-obovate, minutely acute at the rounded apex, 8.5 to 9.5 mm long, 5.5 to 6.5 mm wide, 5-nerved. Labellum 3-lobed; lateral lobes erect, oblong-semiorbicular, oblique, about 7 mm long, 6 mm wide; middle lobe concealed by the lateral lobes, lanceolate, incurved, about 8 mm long. Column short, stout, erect, with the foot 8 to 10 mm long. Anther ovoid; pollinia subglobose.

LUZON, Manila, Mrs. Remedios C. Gonzales's gardens, *Bur. Sci. 85573 Eduardo Quisumbing,* October 26, 1932.

The plants were originally collected by Mr. Aleko Lilius at an altitude of 100 to 130 meters in the hills of Calayan Island, Babuyan group, north of Luzon.

This variety differs from the species in its white flowers, more compact racemes, and more distichous leaves. This extremely rare orchid is remarkable for the elegance of its spikes of pure white, very fragrant flowers, which lasted for over a month. Since its appearance at Mr. W. F. G. Farmer's [4] place in Nonsuch Park, Cheam, England, in 1862, this is the first time it has been shown in Manila, and apparently the second in the world.

Genus LUISIA Gaudichaud

LUISIA CORDATILABIA sp. nov. Plate 3, figs. 9 and 10; Plate 6, figs. 26 to 33; Plate 14, fig. 2.

Herba epiphytica. Caules adscendentes, simplices (ver rarissime ramosi), 30 ad 80 cm alti, 5 ad 6 mm in crassitudine. Folia teretia, 9 ad 13.5 cm longa, 4 ad 5 mm in crassitudine, basi ad vaginas rigidas articulata. Inflorescentiae oppositifoliae; pedunculus circiter 2 cm longus; rhachis crassa; bracteae rigidae, cucullatae, usque ad 4 mm longae. Flores carnosi, rigidi, 1.8 ad 2 cm lati, bracteis triangularibus, acutis, persistentibus subtenti; pedicellus cum ovario 12 ad 13 mm longus. Sepala lateralia valde navicularia, carinata, oblique lanceolata vel ovato-lanceolata, acuta vel subacuta, circiter 11 mm longa, 5 mm lata, 3-nervia. Sepalum dorsale lanceolato-oblongum, ob-

[4] Williams, Orchid Grower's Manual ed. 7 (1894) 90.

with six vinaceous-rufous lines, the two outer ones forking at the base. Column white.

This variety differs from the typical forms of *Vanda lamellata* in its erect stems, short and but slightly curved leaves. The flowers are larger than in usual forms of the species, and the color of the flower is distinct especially the middle lobe of the labellum.

This variety is dedicated to Mrs. Remedios C. Gonzales to whom the junior author owes great favors for her kindness in putting at his disposal for study her large collections of orchids and for her great interest in Philippine orchids.

VANDA MERRILLII Ames and Quisumbing var. IMMACULATA var. nov. Plate 2, figs. 5 and 6.

Haec varietas floribus omnino luteis haud striatis neque maculatis a *Vanda Merrillii* differt.

In habit and flower parts similar to the species. The flowers are slightly larger; the sepals, petals, and middle lobe of the labellum primuline yellow, with pinard yellow in the center. The lateral lobes of the labellum, column, and pedicellate ovary are white.

LUZON, Manila, Mrs. Remedios C. Gonzales's gardens, *Bur. Sci. 85574 Eduardo Quisumbing*, November 8, 1932.

The plant was originally collected by orchid peddlers from the mountains near Atimonan, Tayabas Province, Luzon. Since its arrival in Manila the plant had flowered twice (May 23 and November 8, 1932).

The variety is characterized by the complete absence of bars or maculations on the sepals and petals.

Genus STAUROPSIS Reichenbach f.

This genus was proposed in 1860 (Hamb. Gartenz. 16: 117) and briefly characterized as follows: "Gynostemium apus. Sepala a labello libera." As exemplifying these characters, *Trichoglottis philippinensis* Lindl. was referred here.

Later the genus *Stauropsis* was amplified by Bentham [in Bentham & Hook. f. Gen. Pl. 3 (1883) 572], where the distinction from the allied genera still rested on the footless column, while the lip was described as ecalcarate.

The type description of the allied genus *Trichoglottis* Bl. [Bijdr. (1825) 359] showed the base of the sepals adnate to a distinct column foot and the lip conspicuously spurred.

While several species subsequently referred to *Trichoglottis* appear to have a footless column and spurless lip, the vast ma-

jority of *Trichoglottis*, including all the Philippine orchids which logically belong to that genus, have prominent spurs. It appears to us, therefore, that the genus *Stauropsis* should be retained for the Philippine orchids of this alliance, which are distinguished by an ecalcarate lip and footless column. Accordingly, the following transfers are made and a key to the Philippine members of the genus *Stauropsis* appended.

Key to the Philippine species of Stauropsis.

1. Flowers in racemes; peduncles elongate, about 7 cm long; labellum cruciform, with prominent keel ..... *S. fasciata.*
1. Flowers solitary, opposite the axils of the leaves; peduncles very short or none.
   2. Labellum 5-lobed, cruciform, with prominent elongate keel; middle lobe of labellum elongate, linear.
      3. Lateral lobes of labellum (not the erect basal lobes) narrowly triangular to obliquely quadrate-oblong. *S. philippinensis.*
      3. Lateral lobes of labellum acinaciform-linear; sepals and petals within victoria lake. *S. philippinensis* var. *brachiata.*
   2. Labellum 3-lobed, not cruciform (with short basal lobes only), provided with a distinct rounded callus; middle lobe ovate-lanceolate with a caudate apex..... *S. Wenzelii.*

STAUROPSIS FASCIATA Benth.

Stauropsis fasciata BENTH. apud Jackson in Ind. Kew. (1885) 892; AMES and QUISUMBING in Philip. Journ. Sci. 47 (1932) 214, *pls. 2, 12, 28, and 29.*

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 80831 Eduardo Quisumbing*, May 26, 1930.

The living plants were collected from Atimonan, Tayabas Province, Luzon. They occur also in eastern tropical Asia; namely, Siam, Lankawi, etc.

Stauropsis fasciata Benth. differs from all other Philippine species in its elongate racemes and in the color and form of its flowers.

STAUROPSIS PHILIPPINENSIS (Lindl.) Reichb. f. Plate 2, figs. 11 to 13; Plate 7, figs. 19 to 27; Plate 16, fig. 1.

Stauropsis philippinensis (Lindl.) REICHB. F. in Hamb. Gartenz. 16 (1860) 117, Xen. Orch. 2 (1862) 8, in Walp. Ann. 6 (1864) 882; VIDAL Rev. Pl. Vasc. Filip. (1886) 270; AMES Orch. 2 (1908) 223, 5 (1915) 224, in Merr. Enum. Philip. Fl. Pl. 1 (1925) 440.

Trichoglottis philippinensis LINDL. in Ann. & Mag. Nat. Hist. 15 (1845) 386; NAVES Novis. App. (1882) 243; VIDAL Phan. Cuming. Philip. (1885) 150; USTERI Beitr. Ken. Philip. Veg. (1905) 128; AMES Orch. 7 (1922) 137, in Merr. Enum. Philip. Fl. Pl. 1 (1925) 440.

The original description reads as follows:

"* * * foliis subrotundo-ovatis emarginatis mucrone interjecto, sepalis oblongo-lanceolatis patulis, petalis reflexis linearibus brevioribus, labello esaccato pubescente secus axin villoso oblongo convexo apice hastato-trilobo dentibus baseos brevibus rotundatis. Philippines. Cuming." Lindley, loc. cit.

Tall, branched epiphyte (the herbarium specimens often simple). Roots greatly elongate, simple or branched, whitish. Stems erect (often tending to twist) up to 130 cm high, 5 to 10 mm in diameter, somewhat flattened; internodes up to 2.5 cm long. Leaves light green, oblong, oblong-ovate, or ovate-elliptic, distichous, retuse, mucronate, carinate, 2 to 9 cm long, 1.4 to 3.5 cm wide, thick, rigid. Flowers solitary, opposite the axils of the leaves, odorless or fragrant, lasting for several weeks on the stems without drying, 3 to 3.5 cm across, fleshy. Peduncles very short or none. Bracts imbricate at the base, minute, membranaceous. Lateral sepals ovate to lanceolate, acute, 1.5 to 1.9 cm long, 8 to 10 mm wide, apex abruptly recurved. Dorsal sepal lanceolate-elliptic, acute to subacute, 1.5 to 1.8 cm long, 3.5 to 8 mm wide. Petals narrower than the sepals, linear-oblanceolate or narrowly elliptic-lanceolate, subacute or obtuse, 1.5 to 1.7 cm long, 4 to 4.5 mm wide. Labellum 5-lobed, cruciform, acute, 14 to 19 mm long; two basal lobes erect, triangular, short, subacute or obtuse, 1.75 to 2 mm long, firmly united with the column at the base; lateral lobes near the middle triangular to subquadrate-oblong, acute to obliquely truncate, white, 1.5 to 7.5 mm long. Entire disc laterally flattened and fleshy, 3 to 7 mm thick, strongly angled below near the apex, white, upper surface villose with white hairs; beneath the hairs mallow pink. Between the basal lobes within the shallow sac there is a quadrate yellow hairy appendage. Column fleshy, stout, about 6 mm long.

Cuming 2140 (Philippines), without definite locality (type of *Trichoglottis philippinensis* Lindl. in Herb. Brit. Mus.).

LUZON, Bulacan Province, Angat, *Bur. Sci. 21680 Ramos*, September 23, 1913: Cavite Province, Maragondong, *Merrill 4188*, July 30, 1930: Rizal Province, Mt. Alban, *Loher 6023*, July 9, 1905. NEGROS, Hermosa, *For. Bur. 17460 Curran*, September 29, 1909. CEBU, Algot, *Lange 18630*, November, 1928. PALAWAN, without definite locality, *Watling 17574*, May, 1927. MINDANAO, Surigao Province, Surigao, *Bur. Sci. 34542 Ramos and Pascasio*, April 9, 1919: Misamis Province, without definite

locality, *For. Bur. 19519 W. Klemme,* January, 1911: Davao Province, Astorga, *Copeland, s. n.* April 29, 104; *Mati, Bur. Sci. 49026 Ramos and Edaño,* June 28, 1929. TAWI-TAWI, Sulu Province, *Bur. Sci. 44245 Ramos and Edaño,* July 19, 1924.

A common endemic species in the Philippines, up to 300 meters altitude. The typical form is colored thus: Sepals and petals are margined with primrose yellow, at the center deep colonial buff or honey yellow to orange-cinnamon with the base Etruscan red. Labellum white with mallow pink on both sides of the central ridge; appendage in the sac between the basal lobes yellow. Column white with a liseran purple line around it.

A species characterized by its cruciform 5-lobed labellum and its solitary flowers opposite the axils of the leaves.

In the herbarium of the Bureau of Science are two plants with different colored flowers. These plants must be referred to this species. The data are: (*a*) *Bur. Sci. 85576 Eduardo Quisumbing,* May 20, 1929. Living plant originally was collected by the late Mr. Maximo Ramos from Catanduanes. Sepals and petals white to marguerite yellow, splashed or barred with dragon's blood red or jasper red (Plate 2, fig. 12). (*b*) *Bur. Sci. 85557 Eduardo Quisumbing,* August 8, 1931. Living plant was originally collected in Davao Province, without definite locality. Sepals and petals are madder brown and margined by reed yellow (Plate 2, fig. 13).

STAUROPSIS PHILIPPINENSIS (Lindl.) Reichb. f. var. BRACHIATA (Ames) comb. nov. Plate 3, figs. 11 and 12; Plate 7, figs. 10 to 18; Plate 16, fig. 2.

Trichoglottis brachiata AMES Orch. 7 (1922) 136, in Merr. Enum. Philip. Fl. Pl. 1 (1925) 440.

The original description reads as follows:

"Aff. *T. philippinensis* Lindl. Caules plus minusve 30 cm alti, rigidi, usque ad apicem foliati, vaginis foliorum obtecti, usque ad 8 mm. in crassitudine, internodiis 1.4 cm. longis. Folia plus minusve 4.5 cm. longa, 2.9 cm. lata, oblongo-elliptica, disticha, retusa, apiculata, apiculo rigido, acuto. Flores laterales, e nodis orientes, singuli. Pedicellus cum ovario usque ad 3.5 cm. longus. Sepala lateralia patentia, 21 mm. longa, 11 mm. lata, ovato-lanceolata, acuta, coriacea. Sepalum dorsale simile. Petala 2 cm. longa, 6 mm. lata, anguste lanceolata, utrinque attenuata, subacuta, valde coriacea, patentia. Labellum 19 mm. longum, quinquelobatum, usque ad medium columnae affixum, ecalcaratum, basi saccatum vel valde concavum; lobi basilares erecti, trianguli, carnosi, circa 3 mm. alti, intus minute pubescentes; lobi laterales 8 mm. longi, usque ad 1.5 mm. lati, acinaciformes, apice inaequaliter dentati, utrinque minute pubescentes; lobus terminalis a latere complanatus, 9 mm. longus, 5 mm. altus, carnosus,

cuneato-quadratus, angulo superiore valde elongato, utrinque pubescens, supra pilosus; discus carina valde carnosa ornatus, prope basim appendicula quadrata, truncata, carnosa instructus. Colmuna brevis, 7 mm. longa, minute pubescens." Ames, loc. cit.

Stems erect, rigid, up to 56 cm high, 5 to 8 mm in diameter; internodes 1 to 1.5 cm long. Leaves ovate-oblong or broadly oblong-elliptic, 3 to 8 cm long, 2.5 to 4 cm wide, distichous, thickly coriaceous, rigid, retuse, apiculate; the apicule rigid, acute. Flowers lateral, appearing singly at the nodes opposite the leaves, 3 to 4.5 cm across. Pedicellate ovary twisted, 3 or more cm long. Sepals and petals spreading and star-shaped. Lateral sepals thickly coriaceous, ovate or ovate-lanceolate, acute, 2 to 2.5 cm long, 1 to 1.5 cm wide. Dorsal sepal similar in form and texture, 1.7 to 1.9 cm long, 1 to 1.4 cm wide. Petals thickly coriaceous, lanceolate or oblong-elliptic, narrowed at both ends, subacute or obtuse at the apex, 1.9 to 2 cm long, 6 to 7 mm wide. Labellum 19 to 25 mm long, 5-lobed, adnate to the lower half of the column, ecalcarate, the base saccate or strongly concave; basal lobes erect, triangular, fleshy, 2.5 to 4 mm high, glabrous without and minutely pubescent within; lateral lobes 6 to 8 mm long, up to 4 mm wide, acinaciform, unequally dentate at the apex, minutely pubescent on both surfaces; middle lobe laterally flattened, about 14 to 18 mm long from the base of the basal lobes, 2.5 to 5 mm high, fleshy, elongate-cuneate, disc with a prominent fleshy keel which is pilose above. Between the basal lobes there is a quadrate, truncate callus which is minutely pubescent. Column stout, 7 to 8 mm long, minutely pubescent.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 85613 Eduardo Quisumbing*, August 14, 1930. Living plants were collected by orchid peddlers from Tayabas Province. Other collections in the herbarium of the Bureau of Science, Manila, are as follows: BILIRAN, *Bur. Sci. 18931 McGregor* (type), June 23, 1914. PALAWAN, near the shores between Cataban and Pancol, *Ermitaño 17577*, May, 1927. MINDANAO, Agusan Province, Cabadbaran, *Weber 134* (this number shows transition to *S. philippinensis*) : Davao Province, Todaya, Mount Apo, *Elmer 12021*.

An endemic variety usually found on tree trunks at low altitudes. Sepals and petals light cadmium on the outer surface, victoria lake inside, except the margins, tips, and a central line, which are light cadmium. Labellum rhodamine purple, except the white pilose hairs above the ridge and the center of the lat-

eral lobes of the labellum ivory yellow. Blooms in Manila gardens usually around August. The plants thrive on adobe stone walls and in wooden baskets.

This variety differs from the species in its Victoria lake color of the inside of the flowers, and its elongate, linear, curved lateral lobes of the labellum, which arise near the middle of the central lobe.

STAUROPSIS WENZELII (Ames) comb. nov. Plate 3, figs. 14 and 15; Plate 7, figs. 28 to 35; Plate 17.

Trichoglottis Wenzelii AMES in Philip. Journ. Sci. 8 (1913) Bot. 440, Orch. 5 (1915) 257, in Merr. Enum. Philip. Fl. Pl. 1 (1925) 440.
Trichoglottis retusa AMES in Philip. Journ. Sci. 4 (1909) Bot. 676, non Blume, in Merr. Enum. Philip. Fl. Pl. 1 (1925) 440.

The original description reads as follows:

"Herba epiphytica circiter 30 cm alta, rigida. Caules foliosi, internodiis 1.5–2 cm longis. Foliorum vaginae cylindraceae, supra paulo dilatatae, internodiis aequilongae, laminae valde coriaceae, in sicco rugosae, oblongae, 4.5–6 cm longae, circiter 1.5 cm latae, distichae, ad apicem subaequaliter rotundato-bilobae vel retusae. Inflorescentiae oppositifoliae, foliis breviores. Bracteae rigidae, 2 mm longae. Flores inter maximos generis, purpureo-maculati, circiter 2 cm in diametro. Sepala lateralia oblonga, subacuta ad basim late cuneata, carnosa, 1 cm longa, 6 mm lata. Sepalum dorsale simile. Petala spathulata, 9–10 mm longa, prope apicem 3 mm lata. Labellum breve saccatum, 3-lobatum, lobis lateralibus brevibus obtusis, utrinque pubescentibus, lobo medio elongato, attenuato, sagittato-lanceolato, apice attenuato, acuto, usque ad 13 mm longo, pubescenti. Callus in disco, pubescens. Ligula ante foveam pubescens 4 mm longa. Gynostemium pubescens auriculis elongatis, pilosis, 4 mm longis." Ames, Philip. Journ. Sci. 8 (1913) Bot. 440.

Epiphyte; the roots greatly elongate. Stems rigid, foliose, erect, or more or less arcuate, 25 to 75 cm high, 4 to 7 mm in diameter; internodes 1.5 to 4 cm long. Leaf sheaths cylindric, dilated at the apex, and as long as the internodes. Leaves oblong to ligulate, leathery, rugose when dry, 4 to 12 cm long, 1.1 to 2.5 cm wide, distichous, unequally bilobed or retuse at the apex with rounded lobules. Inflorescences opposite the leaves and much shorter than the leaves. Bracts rigid, tubular, about 2 mm long. Flowers fragrant, in life 1.6 to 1.7 cm across, 2 to 2.5 cm across when fully expanded. Pedicellate ovary somewhat twisted, about 1.3 cm long. Lateral sepals fleshy, ovate to oblong, subacute, 8 to 13 mm long, 5 to 7 mm wide, 6- to 7-nerved. Dorsal sepal oblong-obovate, acute to subacute, apiculate, 7.1 to 11 mm long, 4.2 to 6.25 mm wide, 5- to 6-nerved. Petals spatulate or oblong-spatulate, 7 to 10 mm long, 2 to 3 mm wide at the widest portion, 3-nerved. Labellum 3-lobed, shal-

lowly saccate at the base, fleshy, 12.8 to 17 mm long when expanded; basal lobes short, triangular, obtuse, 1.5 to 2.5 mm long, free portion about 1.6 mm, pubescent; middle lobe ovate to ovate-lanceolate, about 13 mm long, attenuate or caudate at the apex (with tail 5.5 to 7 mm long), glabrous below and pubescent above. Between the basal lobes there is a ligulate, pubescent appendage which is 2.8 to 3 mm long. Keel beneath the middle lobe narrow and thin. Gynostemium pubescent, the auricles elongate, pilose, 2.5 to 2.9 mm long.

LUZON, Tayabas Province, Pitogo, *For. Bur. 9653 Curran*, March 23, 1908: Camarines Sur Province, Mount Bagacay, *Bur. Sci. 33850 Ramos and Edaño*, December 17, 1918. NEGROS, Occidental Negros Province, along Gimogaa River, *For. Bur. 5553 H. D. Everett*, October 26, 1906. LEYTE, Dagami, *Wenzel 15* (Type of *Trichoglottis Wenzelii* Ames), December 8, 1912, *Wenzel 176*. MINDANAO, Surigao Province, Surigao, *F. H. Bolster 225*, January 17, 1906; *W. S. Lyon 127:* Davao Province, Davao, *Rev. R. F. Black, s. n.* 1909: Zamboanga Province, Malasugat, *Merrill 8206*, November–December, 1911. TAWITAWI, Sulu Province, *Bur. Sci. 44262 Ramos and Edaño*, August 22, 1924. BASILAN, *For. Bur. 6103 Hutchinson*, August, 1906. A species growing at lower altitudes. Endemic.

Sepals and petals chalcedony yellow or light green-yellow, striped with amaranth purple. Labellum cream-colored, barred with amaranth purple with the white pilose hairs on the upper surface of the middle lobe.

The species is characterized by having a trilobed labellum, of which the middle lobe is ovate to ovate-lanceolate, attenuate or caudate at the apex.

ILLUSTRATIONS

PLATE 1

FIG. 1. *Dendrobium Aliciae* sp. nov., front view of flower, × 1.
2. *Dendrobium Aliciae* sp. nov., side view of flower, × 1.
3. *Bulbophyllum surigaense* sp. nov., side view of flower, × 1.5.
4. *Bulbophyllum surigaense* sp. nov., front view of flower, × 1.5.
5. *Dendrobium plicatile* Lindl. var. *Convocarii* var. nov., front view of flower, × 1.
6. *Dendrobium plicatile* Lindl. var. *Convocarii* var. nov., side view of flower, × 1.
7. *Cymbidium dayanum* Reichb. f., front view of flower, × 1.
8. *Cymbidium dayanum* Reichb. f., side view of flower, × 1.
9. *Vanda lamellata* Lindl. var. *Remediosae* var. nov., front view of flower, × 1.
10. *Vanda lamellata* Lindl. var. *Remediosae* var. nov., side view of flower, × 1.

PLATE 2

FIG. 1. *Phalaenopsis Micholitzii* Rolfe, front view of flower, × 1 (circa).
2. *Phalaenopsis Micholitzii* Rolfe, side view of flower, × 1 (circa).
3. *Aërides quinquevulnerum* Lindl. var. *album* Williams, side view of flower, × 1.
4. *Aërides quinquevulnerum* Lindl. var. *album* Williams, front view of flower, × 1.
5. *Vanda Merrillii* Ames and Quisumbing var. *immaculata* var. nov., front view of flower, × 1.
6. *Vanda Merrillii* Ames and Quisumbing var. *immaculata* var. nov., side view of flower, × 1.
7. *Phalaenopsis equestris* (Schauer) Reichb. f. var. *leucotanthe* Reichb. f., front view of flower, × 1.
8. *Phalaenopsis equestris* (Schauer) Reichb. f. var. *leucotanthe* Reichb. f., side of view of flower, × 1.
9. *Sarcochilus unguiculatus* Lindl., front view of flower, × 1.
10. *Sarcochilus unguiculatus* Lindl., side view of flower, × 1.
11. *Stauropsis philippinensis* (Lindl.) Reichb. f., (typical form), front view of flower, × 1.
12. *Stauropsis philippinensis* (Lindl.) Reichb. f., front view of flower, × 1.
13. *Stauropsis philippinensis* (Lindl.) Reichb. f., front view of flower, × 1.
14. *Stauropsis Wenzelii* (Ames) comb. nov., front view of flower, × 1.
15. *Stauropsis Wenzelii* (Ames) comb. nov., side view of flower, × 1.

PLATE 3

FIG. 1. *Aërides Jarckianum* Schltr., front view of flower, × 2.
2. *Aërides Jarckianum* Schltr., side view of flower, × 2.
3. *Aërides Jarckianum* Schltr. var. *Smithii* var. nov., front view of flower, × 2.
4. *Aërides Jarckianum* Schltr. var. *Smithii* var. nov., side view of flower, × 2.
5. *Dendrobium irayense* sp. nov., front view of flower, × 2.
6. *Dendrobium irayense* sp. nov., side view of flower, × 2.
7. *Dendrobium Yeageri* sp. nov., front view of flower, × 1 (circa).
8. *Dendrobium Yeageri* sp. nov., side view of flower, × 1 (circa).
9. *Luisia cordatilabia* sp. nov., front view of flower, × 2.
10. *Luisia cordatilabia* sp. nov., side view of flower, × 2.
11. *Stauropsis philippinensis* (Lindl.) Reichb. f. var. *brachiata* (Ames) comb. nov., front view of flower, × 1.
12. *Stauropsis philippinensis* (Lindl.) Reichb. f. var. *brachiata* (Ames) comb. nov., side view of flower, × 1.

PLATE 4

Dendrobium Aliciae sp. nov.: *1*, dorsal sepal, × 1.5; *2*, lateral sepal, × 1.5; *3*, petal, × 1.5; *4*, front view of column and labellum (natural position), × 2.5 (circa); *5*, labellum from above, stretched out, × 3; *6*, side view of ovary, column, and labellum (natural position), × 3; *7*, anther from above, (enlarged); *8*, anther from below, (enlarged); *9*, pollinia, (enlarged).

Dendrobium plicatile Lindl. var. *Convocarii* var. nov.: *10*, dorsal sepal, × 1 (circa); *11*, lateral sepal, × 1 (circa); *12*, petal, × 1 (circa); *13*, front view of column, and labellum (natural position), × 1.5 (circa); *14*, labellum from above, stretched out, × 1.5 (circa); *15*, side view of column, ovary, and labellum (natural position), × 1.5 (circa); *16*, anther from below, × 6; *17*, anther from above, × 6; *18*, group of pollinia, × 6.5; *19*, a pollinium, × 6.5.

Dendrobium irayense sp. nov.: *20*, dorsal sepal, × 2 (circa); *21*, lateral sepal, × 2 (circa); *22*, petal, × 2 (circa); *23*, side view of pedicellate ovary, column, and labellum (natural position), × 2.4 (circa); *24*, labellum from above (flattened), × 2.4 (circa); *25*, front view of column, × 1.5 (circa); *26*, anther from above, × 10 circa); *27*, anther from below, × 10 (circa); *28*, pollinia, × 8 (circa).

Dendrobium Yeageri sp. nov.: *29*, dorsal sepal, × 1.5 (circa); *30*, petal, × 1.5 (circa); *31*, lateral sepal, × 1.5 (circa); *32*, labellum from above (stretched out), × 1.5 (circa); *33*, side view of labellum, column, and pedicellate ovary (natural position), × 1.5 (circa); *34*, anther from above, × 7; *35*, anther from below, × 7; *36*, front view of column, × 1.5 (circa); *37*, pollinia, × 7.

PLATE 5

Bulbophyllum surigaense sp. nov.: *1*, a bract, × 3 (circa); *2*, dorsal sepal, × 3 (circa); *3*, lateral sepal, × 3 (circa); *4*, petal, × 3 (circa); *5*, front view of column, and labellum (natural position), × 6 (circa); *6*, side view of ovary, column, and labellum (natural position), × 6 (circa); *7*, anther from above, × 14; *8*, anther from below, × 14; *9*, pollinia, × 14.

Cymbidium dayanum Reichb. f.: *10*, dorsal sepal, × 1 (circa); *11*, lateral sepal, × 1 (circa); *12*, petal, × 1 (circa); *13*, side view of column, and labellum (natural position), × 1.5 (circa); *14*, front view of column, and labellum from above (stretched out), × 1.5 (circa); *15*, anther from above, × 8 (circa); *16*, anther from below, × 8 (circa); *17*, pollinia, × 8 (circa).

Sarcochilus unguiculatus Lindl.: *18*, dorsal sepal, × 2; *19*, petal, × 2; *20*, lateral sepal, × 2; *21*, side view of column, and labellum (natural position), × 2; *22*, column and labellum from above, with the lateral lobes of the labellum stretched out, × 2; *23*, front view of column without anther, × 8; *24*, fruit, × 1 (circa).

Phalaenopsis Micholitzii Rolfe: *25*, dorsal sepal, × 0.75; *26*, petal × 0.75; *27*, lateral sepal, × 0.75; *28*, side view of column, and labellum (natural position), × 1.5; *29*, front view of column, and labellum (natural position), × 1.5; *30*, labellum from above (stretched out) 1.5; *31*, anther from above, × 4.5; *32*, anther from below, × 4.5; *33*, pollinia, × 7.5.

PLATE 6

Aërides Jarckianum Schltr.: *1*, dorsal sepal, × 3; *2*, lateral sepal, × 3; *3*, petal, × 3; *4*, side view of pedicellate ovary, column, and labellum (natural position), × 2 (circa); *5*, front view of column, and labellum (natural position), × 2 (circa); *6*, anther from above, × 6 (circa); *7*, anther from below, × 6 (circa); *8*, pollinia, × 9 (circa).

Aërides Jarckianum Schltr. var. *Smithii* var. nov.: *9*, dorsal sepal, × 3 (circa); *10*, lateral sepal, × 3 (circa); *11*, petal, × 3 (circa); *12*, side view of pedicellate ovary, column, and labellum (natural position), × 2 (circa); *13*, front view of column, and labellum (natural position), × 2 (circa); *14*, anther from above, × 6 (circa); *15*, anther from below, × 6 (circa); *16*, pollinia, × 9 (circa).

Aërides quinquevulnerum Lindl. var. *album* Williams: *17*, dorsal sepal, × 3 (circa); *18*, lateral sepal, × 3 (circa); *19*, petal, × 3 (circa); *20*, front view of labellum (natural position), × 4; *21*, side view of labellum, and portion of column (natural position), × 2 (circa); *22*, front view of column, × 2 (circa); *23*, an-

ther from above, × 5 (circa); *24*, anther from below, × 5 (circa); *25*, pollinia, × 10 (circa).

Luisia cordatilabia sp. nov.: *26*, dorsal sepal, × 2 (circa); *27*, petal, × 2 (circa); *28*, lateral sepal, × 2 (circa); *29*, front view of column, and labellum (natural position), × 2 (circa); *30*, side of pedicellate ovary, column, and labellum (natural position), × 2 (circa); *31*, anther from above, × 4 (circa); *32*, anther from below, × 4 (circa); *33*, pollinia in two views, × 4 (circa).

PLATE 7

Vanda lamellata Lindl. var. *Remediosae* var. nov.: *1*, dorsal sepal, × 1.5 (circa); *2*, lateral sepal, × 1.5 (circa); *3*, petal, × 1.5 (circa); *4*, side view of ovary, column, and labellum (natural position), × 2 (circa); *5*, labellum from above (natural position), × 2 (circa); *6*, labellum from above (stretched out), × 2 (circa); *7*, anther from above, × 8 (circa); *8*, anther from below, × 8 (circa); *9*, pollinium, × 8 (circa).

Stauropsis philippinensis Lindl. var. *brachiata* (Ames) comb. nov.: *10*, dorsal sepal, × 2; *11*, petal, × 2; *12*, lateral sepal, × 2; *13*, side view of ovary, column, and labellum (natural position), × 2; *14*, column and labellum from above (natural position), × 2; *15*, labellum from above (stretched out), × 2; *16*, anther from above, × 5.5 (circa); *17*, anther from below, × 5.5 (circa); *18*, pollinia, × 5.5 (circa).

Stauropsis philippinensis (Lindl.) Reichb. f.: *19*, dorsal sepal, × 1.5 (circa); *20*, lateral sepal, × 1.5 (circa); *21*, petal, × 1.5 (circa); *22*, labellum from above with lateral lobes stretched out, × 1.5 (circa); *23*, side view of ovary, column, and labellum, (natural position), × 1.5 (circa); *24*, front view of column, and labellum (natural position), × 1.5 (circa); *25*, anther from above, × 8 (circa); *26*, anther from below, × 8 (circa); *27*, pollinia, × 8 (circa).

Stauropsis Wenzelii (Ames) comb. nov.: *28*, dorsal sepal, × 2 (circa); *29*, lateral sepal, × 2 (circa); *30*, petal, × 2 (circa); *31*, side view of ovary, column, and labellum (natural position), × 2 (circa); *32*, labellum from above, stretched out, × 2 (circa); *33*, front view of column, and labellum, × 2 (circa); *34*, views of anthers from above and from below, × 8 (circa); *35*, pollinia, × 8 (circa).

PLATE 8

FIG. 1. *Dendrobium Aliciae* sp. nov., habit, very much reduced.
2. *Dendrobium plicatile* Lindl. var. *Convocarii* var. nov., habit, very much reduced.

PLATE 9

FIG. 1. *Dendrobium irayense* sp. nov., habit, very much reduced.
2. *Dendrobium Yeageri* sp. nov., habit very much reduced.

PLATE 10

FIG. 1. *Bulbophyllum surigaense* sp. nov. habit, very much reduced.
2. *Bulbophyllum surigaense* sp. nov., flowers, almost natural size.

PLATE 11

FIG. 1. *Cymbidium dayanum* Reichb. f., habit, very much reduced.
2. *Phalaenopsis equestris* (Schauer) Reichb. f. var. *leucotanthe* Reichb. f., habit, reduced.

PLATE 12

FIG. 1. *Sarcochilus unguiculatus* Lindl., habit, and fruits, much reduced.
2. *Phalaenopsis Micholitzii* Rolfe, habit, much reduced.

PLATE 13

FIG. 1. *Aërides Jarckianum* Schltr., habit, very much reduced.
2. *Aërides Jarckianum* Schltr. var. *Smithii* var. nov., habit, very much reduced.

PLATE 14

FIG. 1. *Aërides quinquevulnerum* Lindl. var. *album* Williams, habit, very much reduced.
2. *Luisia cordatilabia* sp. nov., habit, very much reduced.

PLATE 15

FIG. 1. *Vanda lamellata* Lindl. var. *Remediosae* var. nov., habit, very much reduced.
2. *Vanda lamellata* Lindl. var. *Remediosae* var. nov., flowers, slightly enlarged.

PLATE 16

FIG. 1. *Stauropsis philippinensis* (Lindl.) Reichb. f., habit, very much reduced.
2. *Stauropsis philippinensis* (Lindl.) Reichb. f. var. *brachiata* (Ames) comb. nov., habit, very much reduced.

PLATE 17

Stauropsis Wenzelii (Ames) comb. nov., habit, very much reduced.

PLATE 1.

PLATE 2.

PLATE 3.

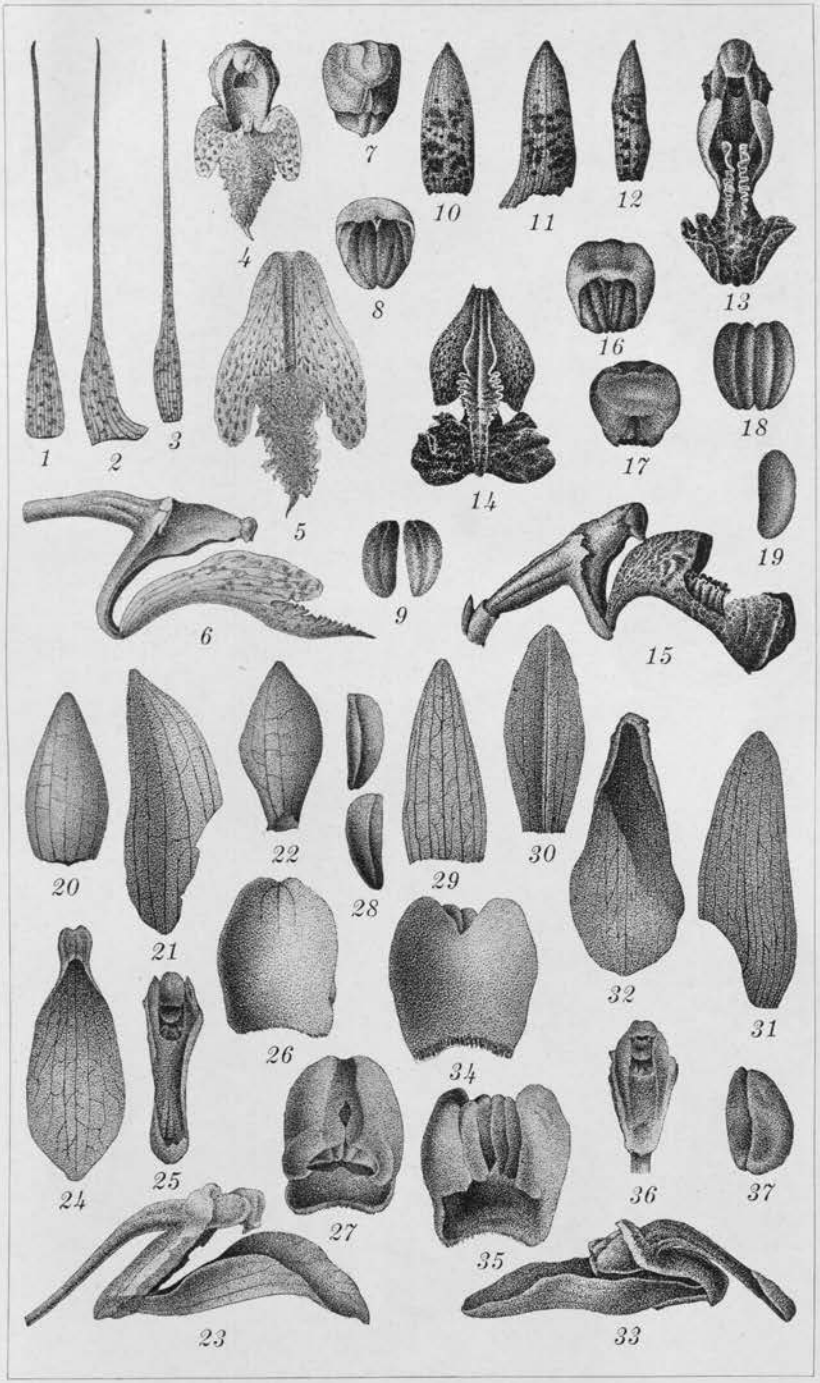
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PLATE 4.

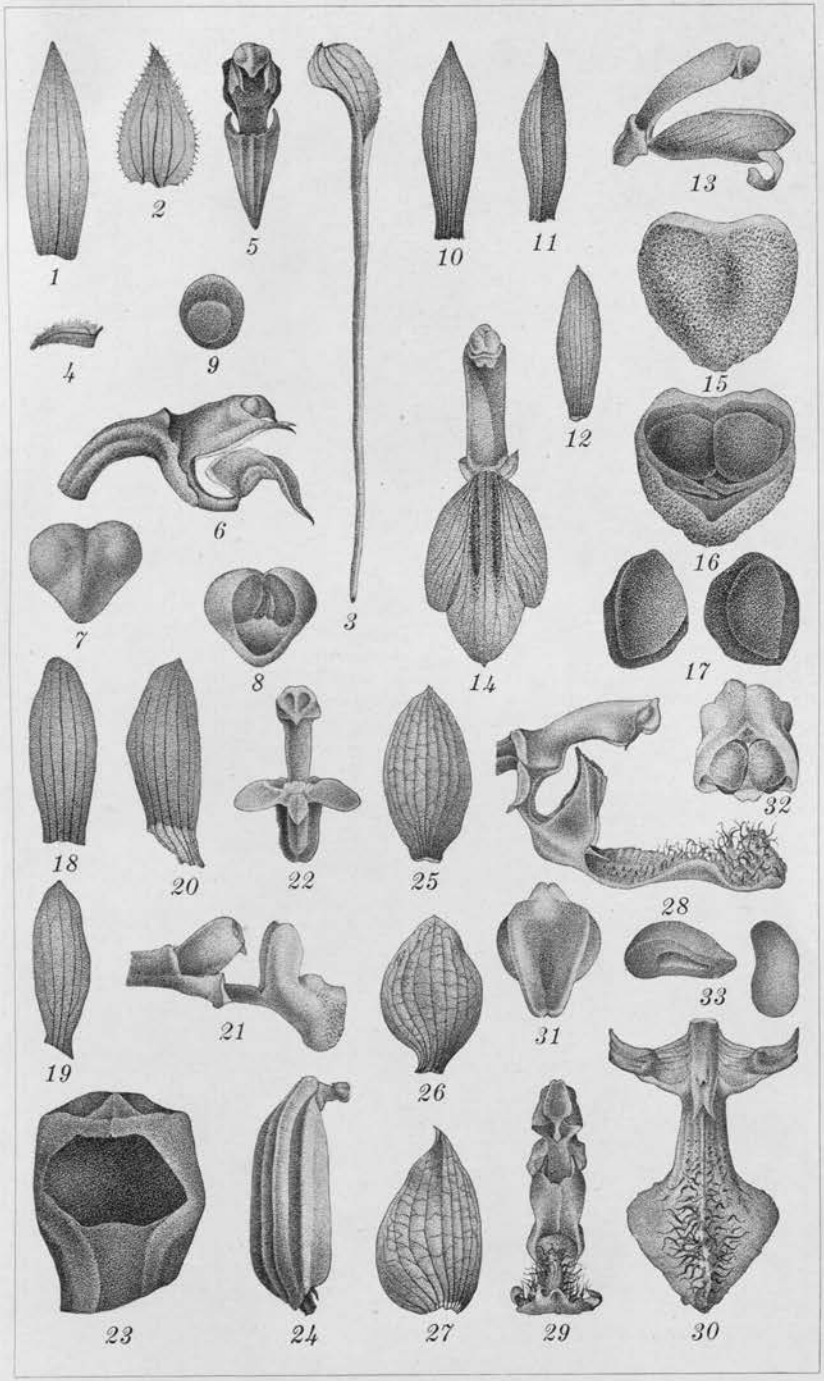
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PLATE 5.

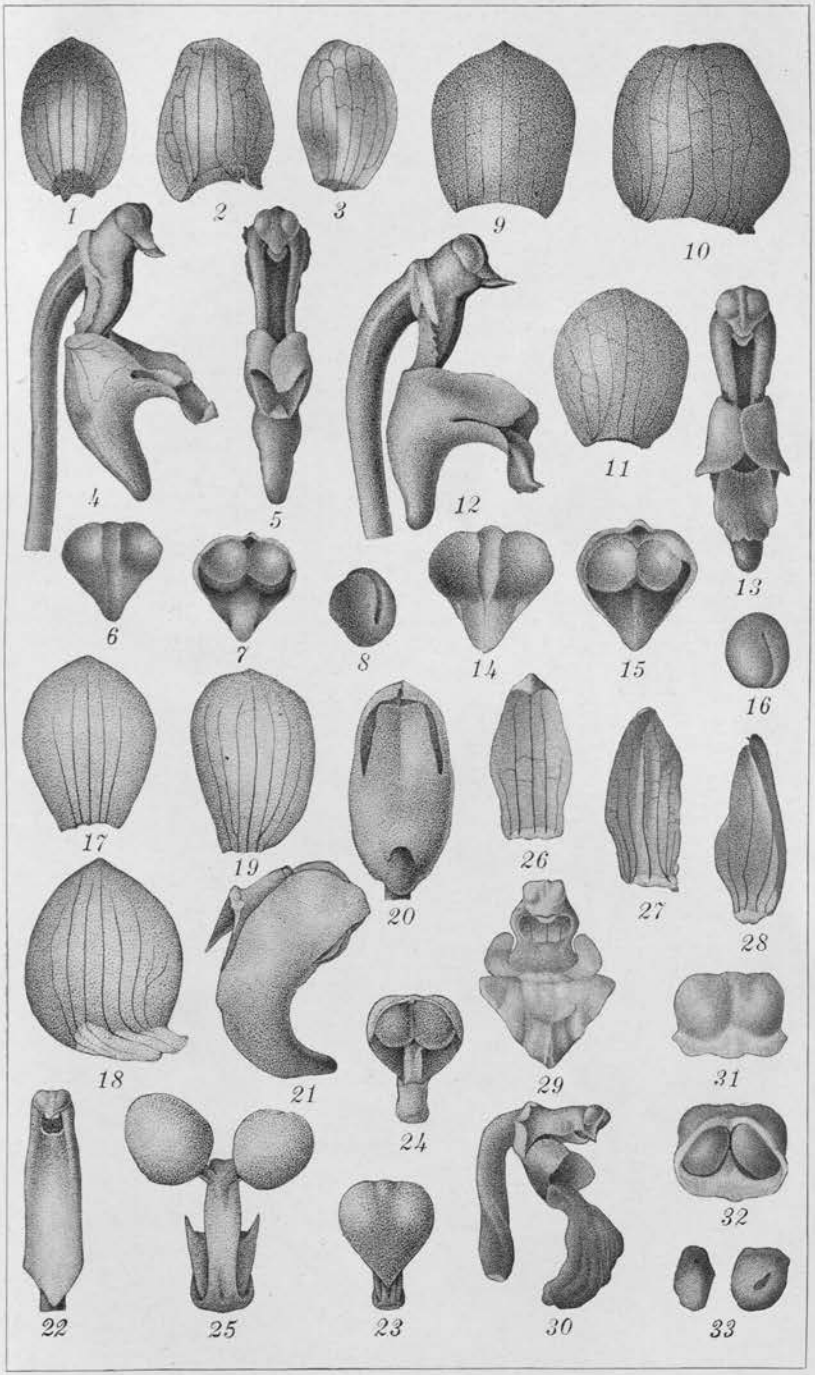
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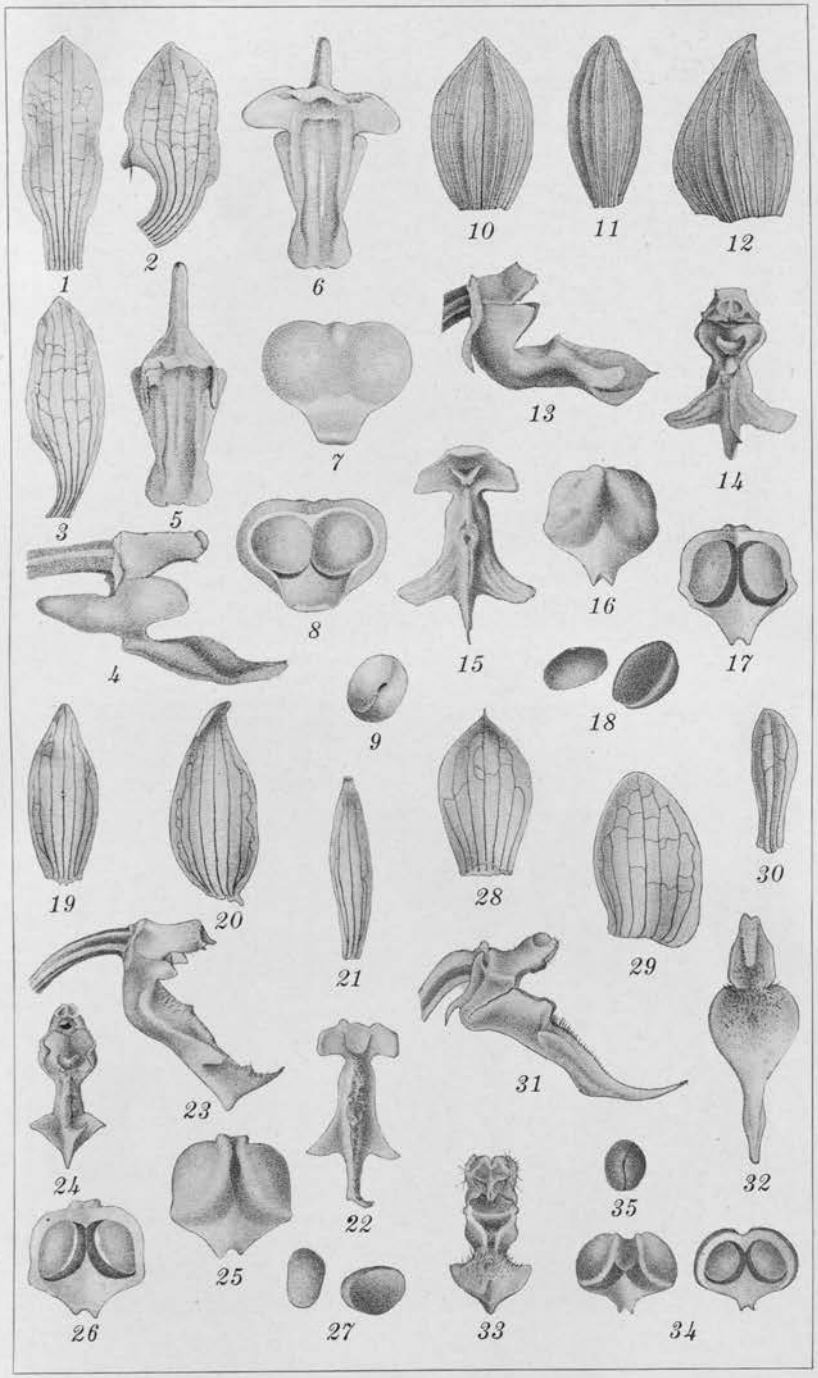
PLATE 6.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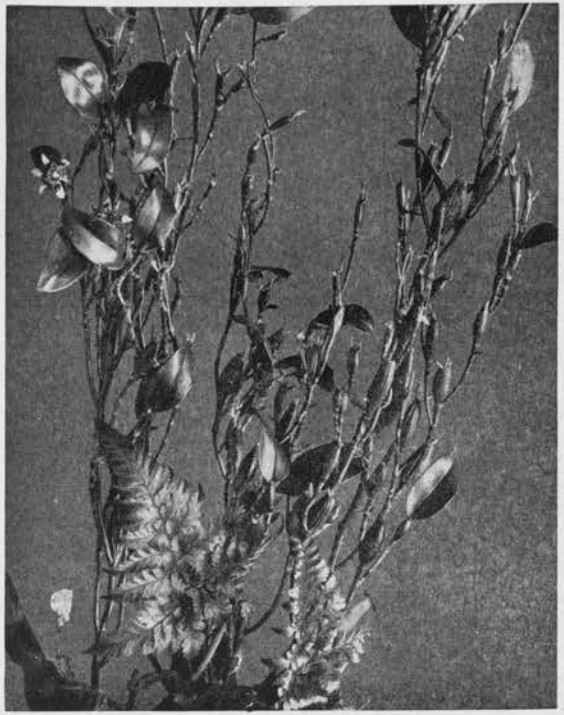

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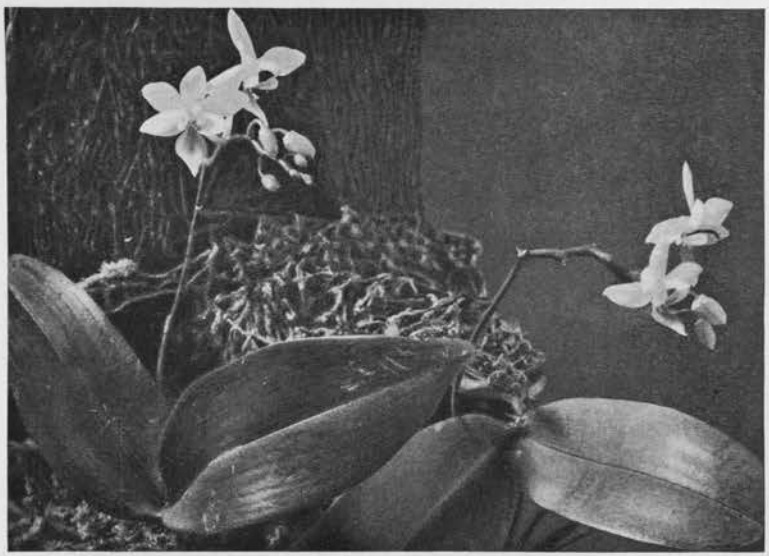

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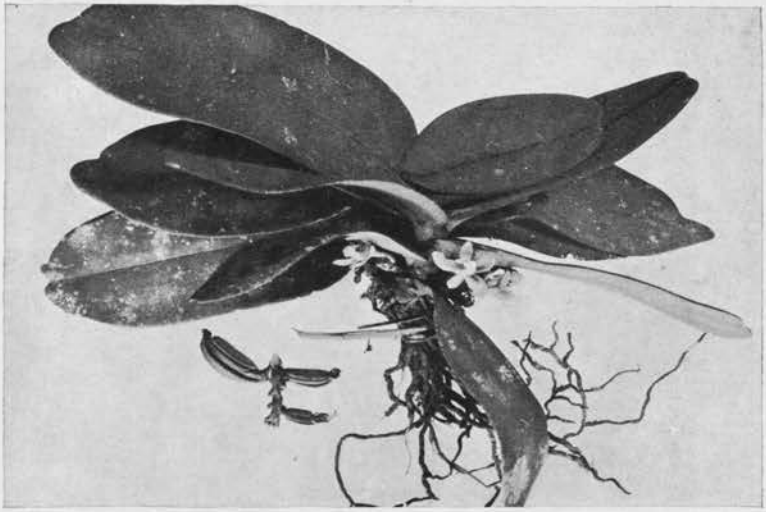

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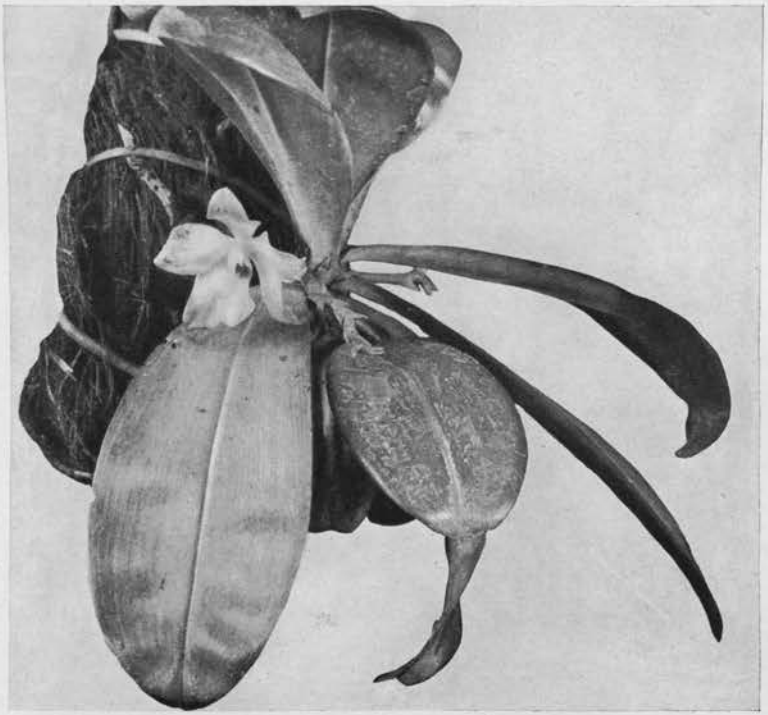

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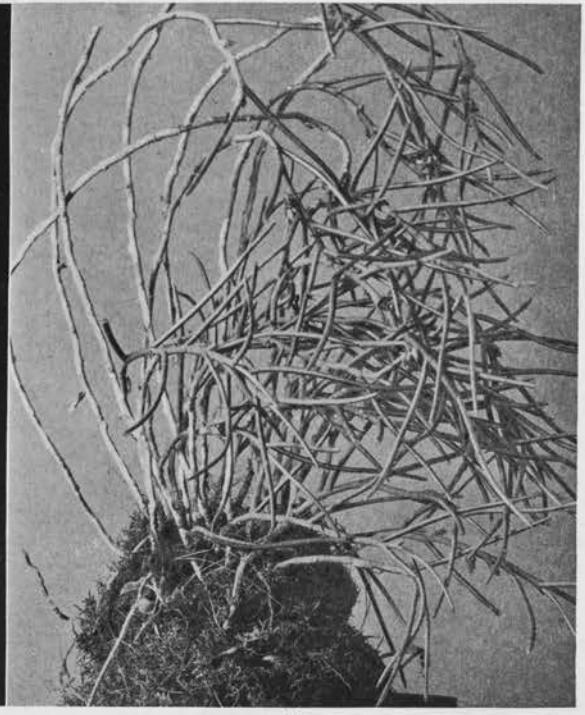

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PLATE 17.

MORPHOLOGY OF THE FLOWER AND MATURE GRAIN OF PHILIPPINE RICE

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SEVEN PLATES AND FIVE TEXT FIGURES

The rice plant (*Oryza sativa* Linnæus) has been investigated extensively as to its external morphology, classification, water and mineral requirements, experimental selection, breeding, nutrition, and nutritive properties. However, little is known concerning the internal structure of the rice plant, particularly the spikelet and mature fruit (caryopsis). Recently, some interesting data along this line were obtained, the results of which are recorded in this paper.

A survey of the available literature referring to this subject reveals that the only published accounts, as far as the writer is aware, are those of Weatherwax,(16) Robbins,(7) and Haan.(3)

Weatherwax,(16) in discussing the spikelets of six genera of Oryzæ, states that in rice the lemma has five vascular bundles and the palea only three, instead of three in the lemma and two in the palea, as previously reported by Hitchcoek. Robbins(7) indicates in his textbook on crop plants that in the cross section of the rice grain the layers are very similar to those of wheat. That is, they consist of the pericarp of several layers, the testa, the nucellus (perisperm), and the aleurone layer.

It apears that Haan(3) was the first to make a detailed study of the internal morphology of rice. He worked out not only the microscopical structure of the essential parts of the spikelet and mature rice grain, but also the structure of the leaf, stem, and root. However, in his description of the parts of the spikelet, apparently no mention is made of the structure and number of vascular bundles in the lemma and in the palea. Furthermore, his descriptions are by no means complete. A further study of the spikelet and mature rice grain therefore seems desirable.

MATERIALS AND METHODS

The young spikelets used in the detailed study of the flowering glume, palea, and ovary wall were obtained from the inflores-

cences of the variety kinampupoy, collected by Mr. Eulalio Gutierrez in November, 1932, at the Alabang Rice Experiment Station, Rizal Province, Luzon. The inflorescences were gathered during and after the period of pollination. All the mature spikelets were also obtained at Alabang by Mr. Gaudencio Reyes, formerly of the Bureau of Science, now of the Bureau of Plant Industry.

The materials used for studying the structure of partially as well as highly polished rice and commercial rice bran were obtained from a rice mill in Arayat, Pampanga Province. The pure unsifted rice bran was obtained from a mill in Parañaque, Rizal Province.

The young spikelets were held between pieces of the dried pitch of *Manihot utilissima* and cut from 15 to 30 μ in thickness by means of a sliding microtome. The ovaries of different stages were dissected from the spikelets, pickled with strong Flemming's fixative, washed with water, dehydrated, embedded in paraffin, and cut from 10 to 15 μ in thickness in a Spencer rotary microtome. The free-hand sections were stained with safranin and Delafield's hæmatoxylin and mounted in balsam, whereas the paraffin sections were stained with iron-alum-hæmatoxylin and mounted in balsam. The mature grain was soaked in water for about twelve hours before it was cut in the sliding microtome. It was difficult to section because the silica it contained made it very brittle. Consequently, the observations of the hull were made mostly from macerated material. For this purpose Schultze's maceration process, as described by Greenish,(2) was employed, with slight modifications, and gave fairly satisfactory results. The macerated material was examined, with or without a stain, and mounted in water, dilute glycerine, or chloral hydrate. Examinations of the rice bran were made from specimens mounted in dilute glycerine and, in some cases, in chloral hydrate solution.

For the determination and localization of the food stored in the rice grain, the following reagents were used: Tincture of alkana, 1 per cent osmic acid solution, iodopotassium iodide solution, picric acid solution (saturated), and Fehling's solution. The vegetable fatty oil is stained pink by tincture of alkana and brown by osmic acid solution; the protein matter is colored yellow or brown by a solution of iodine and yellow by picric acid; the starch grains are colored blue by iodine solution. Sugar reduces Fehling's solution, forming a reddish brown precipitate.

Some of the sections used for the microchemical detection of the food stored in the embryo were free-hand sections made by means of a safety-razor blade. The grains were soaked in water for about five hours before cutting. A grain was held between two fingers, and the razor blade applied gradually to the protruding end.

SPIKELETS

The spikelets occur in panicles and each is articulated in a minute depression in the enlarged end of the pedicel. The mar-

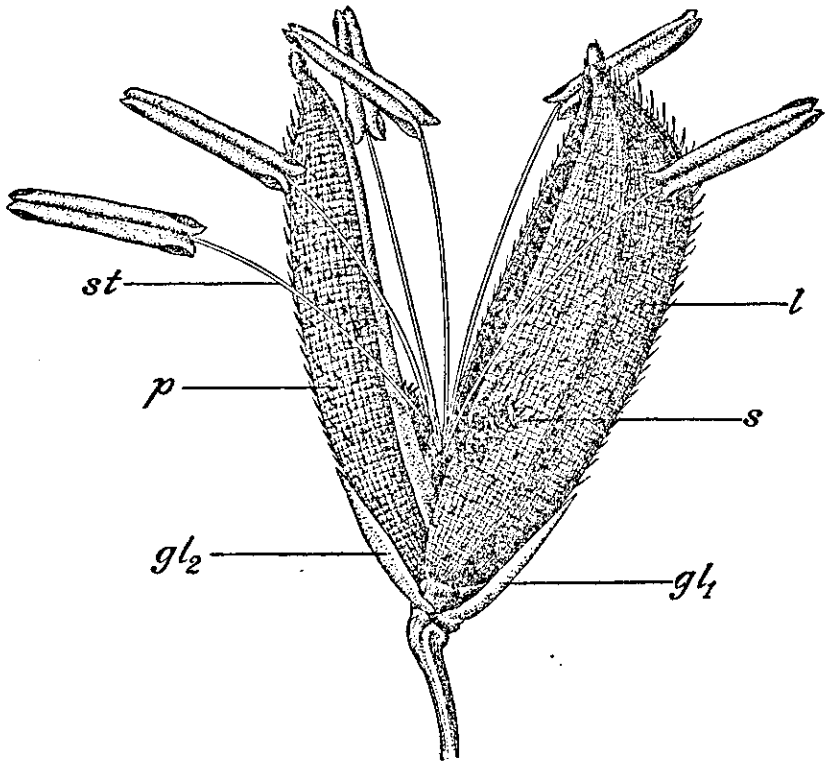

FIG. 1. An open flower of the rice variety kinampupoy; gl_1, first outer empty glume; gl_2, second outer empty glume; *l*, lemma; *p*, palea; *s*, stigma; *st*, stamen; × 10.

gin of this depression is lobed in a bractletlike structure, which if sufficiently elongated, can be mistaken for glumes. The pedicels are arranged either singly or in pairs. The spikelet is laterally compressed, one-flowered, and composed of two small glumes, a flowering glume, a palea, two lodicules, six stamens, and a pistil (text fig. 1).

The first and second small empty glumes are scalelike or bristlelike. They are one-nerved, smooth and shiny on the outer surface, and whitish green or light yellowish white, which becomes ivory white in the mature glume.

The third (flowering) glume is about three times as long as the outer glumes. It is boat-shaped, five-nerved, chartaceous, laterally compressed, and light green. When it matures, however, it becomes usually pale yellowish white or straw yellow. The outer surface is somewhat rough or sandy, highly silicified, and has either few or many simple hairs. The apex is obtuse or acute.

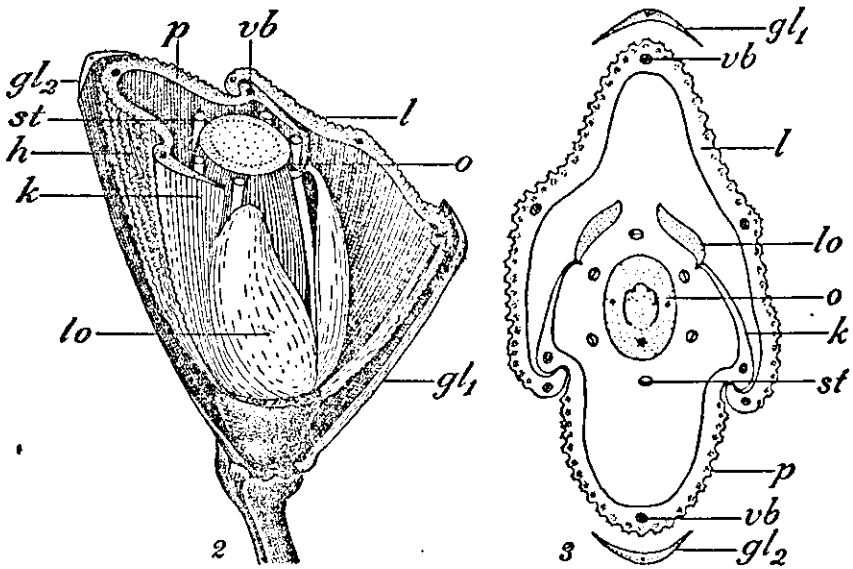

FIG. 2. A diagrammatic drawing of a cross section of a rice flower with a portion of the lemma removed to show the relative position of its essential parts.

FIG. 3. A rice floral diagram; gl_1, first outer empty glume; gl_2, second outer empty glume; *l*, lemma; *p*, palea; *k*, keel; *lo*, lodicule; *h*, hair; *o*, ovary; *st*, stamen; *vb*, vascular bundle.

The palea is the structure next to the flowering glume or lemma. It is very similar to the flowering glume in texture, general appearance, and color, except that it is slightly smaller, keeled, and has only three nerves. Again, at the lower ventral part of the palea, there are two minute structures, known as lodicules, which are attached to the lower edges for most of their length. These minute structures are oval or broadly oval in outline, thick and fleshy in character.

The stamens, six in number, are linear in outline, with long filaments, and split or dehisce at the lateral sides. The pistil is characterized by two plumose stigmas which are usually light

yellow in color, although sometimes the color may vary from purple to red. The style is very short. The ovary is ovoid in shape and has one ovule attached at the lateral and lower side of the ovary wall opposite the lowest and small empty glume.

The rice flower opens slowly in the morning, usually between 9 and 11 o'clock, and the first parts of the flower to appear are the stamens. As soon as the lemma and palea become extended in their full length, they open and the stigmas protrude. This phase is immediately followed by the bursting of the anthers, and pollination takes place. Soon after pollination the stigmas draw back between the palea and lemma, although in some cases they remain protruding outside.

The blooming period of the rice flower and the length of time it remains open have been observed to differ with the variety, country, and climatic conditions.

In India, Sharngapani(10) observed that early paddy (*aus*) rice sown in April and May blooms in July and August and the flowers open about 7 a. m. The transplanted paddy (*sail*) rice blooms in October, and the flowers open at about 9 a. m. Hector(4) observed that in lower Bengal during May and June the rice flowers usually begin to open between 7 and 8 a. m., and continue until about 10 a. m. In late October and early November, the flowers begin to open two hours later and continue until noon. Thompstone(14) noted that in upper Burma as in India the opening of rice flowers usually occurs between 7 and 10 a. m. Stok(11) states that in Java the greater number of rice blossoms open between 10 and 12 a. m., although in some cases they open between 9 and 10 a. m. and between 12 and 1 p. m. Jones(5) reported that in California the rice flower opens between 12 and 2 p. m. On the other hand both Torres(15) and Rodrigo(8) in the Philippines observed that the rice blossoms generally open between 9 and 11.30 a. m.

As to how long the rice flower remains open, Hector(4) found that among the varieties that bloom early in the season the flowers seldom remain open longer than half an hour, while in late varieties they remain open from one to one and one-half hours. Rodrigo(8) claims that the flower of the binicol variety of rice remains open 54.7 minutes on the average, the inintiw variety 48 minutes, and the binambang 55 minutes.

The closing of the flower is also gradual. The edges of the lemma are brought slowly in contact with those of the palea until they curl up slightly and roll about each other as shown in text figs. 2 and 3. With a mature spikelet the edges of the lemma

and palea become strongly and firmly fastened to each other, forming the hull, so that it is very difficult to separate one from the other without cracking a fragment of the lemma or palea. From an ordinary examination of the two structures that constitute the hull of the rice grain it apears that they are intimately united as if the hull were made up of a single continuous piece; however, in a cross section of the spikelet, it is readily observed that the edges of the lemma are simply hooked or inserted tightly into the sides of the palea.

During the ripening period there are notable changes in the appearance and structure of the spikelet. The first change observed is that the spikelet becomes stouter and turgid and the color changes gradually from pale green to dark green. This change is probably due to the resorption of some of the contents of the several layers of the ovary wall and their subsequent compression due to the enlargement of the endosperm through which the chlorophyllous layers become more conspicuous. At this (milky) stage the embryo is fully developed and the endosperm cells are filled to capacity with a watery sap. Numerous starch grains are suspended in this sap, and when the spikelet or grain is squeezed it exudes a white, milky juice.

In the next stage of ripening the spikelet begins to change gradually from green to yellowish white or straw color, and the endosperm becomes tough and waxy. Soon after that the spikelet acquires a yellowish white color. Due to loss of water the hull contracts and the different cell layers become considerably distorted and compressed. As a result the spikelet gradually develops into a hard, firm grain.

The mature grain of the variety kinampupoy follows the outline, or shape, of a closed flower (spikelet) except that it is thicker, due to the development of the endosperm (text fig. 4). It varies from 6.5 to 9 millimeters in length, from 3.2 to 4 millimeters in width, and from 2 to 2.6 millimeters in thickness. It is yellowish white or straw colored. Some rice varieties, however, show variation in color. They may be reddish brown, orange, purplish black, etc.

The fruit, or grain proper (kernel), is inclosed within the hull, which is formed by the lemma and palea tightly fastened to each other (text fig. 5). When this outer covering (hull) is carefully removed the grain appears to correspond more or less to the shape of the spikelets. It is oblong-oval and, in cross section, appears elliptical. In some rice varieties the fruit has a more-rounded form and in certain others it is more elongated.

The outer surface of the fruit (kernel) of kinampupoy is generally smooth and glistening. It has two longitudinal parallel ridges on each of the flat surfaces. On one side of the lower part there is a sort of slanting shallow cavity where the embryo is located. This is found opposite to the lowest and small empty glume. The rice kernel is surrounded by a filmlike structure which corresponds to a pericarp together with the seed coat in an ordinary dicotyledonous fruit. The color of the rice kernel

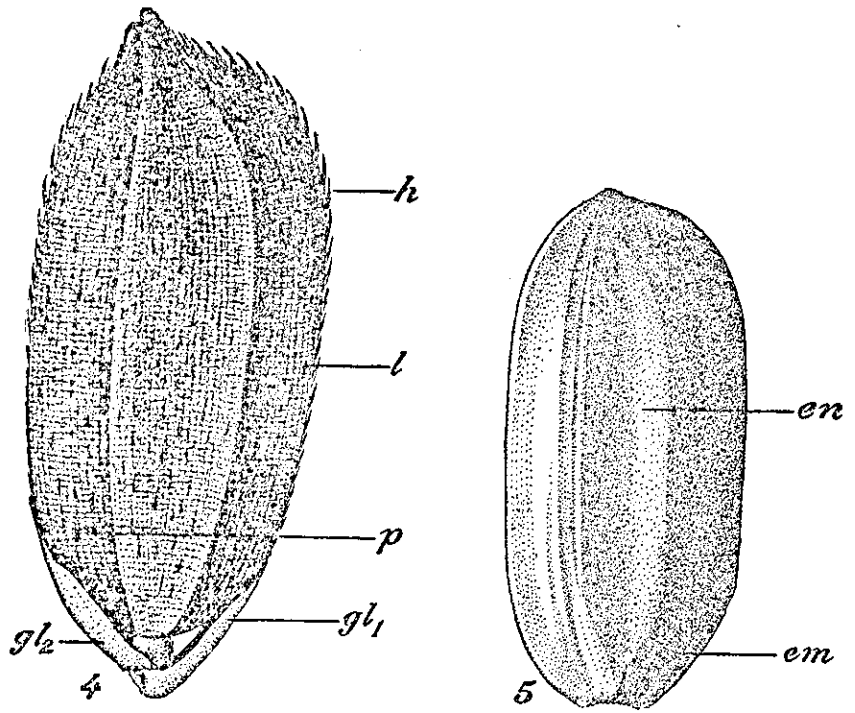

FIG. 4. A habit drawing of a kinampupoy rice grain; gl_1, first outer empty glume; gl_2, second outer empty glume; *l*, lemma; *p*, palea; *h*, hair; × 10.
FIG. 5. A habit drawing of a kinampupoy rice kernel; *en*, endosperm; *em*, embryo; × 10.

depends upon the color of this filmy covering. In most cases this covering is transparent, whitish, or very light cream in color; in some cases it is red and in others violet-black or purplish black. In the kinampupoy and macan varieties the color is either transparent and white or reddish brown. A majority of the grains of the common varieties of rice are glistening and transparent, usually with a chalky white portion at the middle ventral side, known as abdominal white. The transparent characteristic of the grain is due to the glassy, or transluscent, waxy

white property of the endosperm. The abdominal white is generally very distinct in the short and coarse grains of the Philippine varieties of rice. Usually it occurs along the edge of the ventral side and approaches the center and sometimes extends even to the peripheral side of the grain. In the case of fine slender grains, however, it usually appears only slightly or is entirely inconspicuous.

MICROSCOPIC STRUCTURE OF THE SPIKELET

A thin cross section of the young spikelet (flower) shows that the outer part (immature hull) is more or less elliptic and wavy in outline and consists essentially of two parts; namely, lemma and palea. The lemma simulates the inverted italic letter *V* and the palea the inverted letter omega Ω. The lemma and palea are united by the interlocking of the free ends (text figs. 2 and 3, and Plate 3, fig. 29). The lemma is decidedly larger than the palea. It has a dentate margin and five vascular bundles. The principal vascular bundle is located at the middle of the lemma. It corresponds to the vascular bundle of the midrib in a cross section of a leaf. Two vascular bundles are located in the lateral part of the lemma and the remaining two are situated close to the ends. The free ends of the lemma are bent inward in the form of hooks. The palea also has a dentate margin but only three vascular bundles, one in the middle and two at the base of the keels.

The lemma is almost uniform in thickness, measuring about 0.12 millimeter. The outer part is limited by large epidermal cells, which have very thick walls that are somewhat corrugated, slightly lignified, pitted, and siliceous. The outer surface is lined up or protected by an irregular, thin and dentated silicate substance (Plate 2, fig. 12). In the surface view the epidermal cells are very characteristic, and they are arranged in axial rows with unicellular, simple hairs regularly distributed among them. Plate 2, fig. 14, shows a portion of the surface view of the characteristic epidermal cells of the lemma with one simple hair. The epidermal cells are dentately parted at the lateral sides and their walls border on each other (Plate 2, fig. 15). The sharp, elongated, small teeth are interlocked with those of the lateral neighboring cells in such a way that they grasp each other. The simple hairs are observed to be evenly distributed at regular intervals and are inserted between the epidermal cells. They vary in length. The hairs on the dorsal part are larger than those scattered on the lateral surface. When young, these hairs

appear to have thin walls near the tip and thicker walls toward the base; but as they get older, their walls become very thick throughout, lignified, silicified, and their cavity is considerably reduced in size. Just beneath the remarkable epidermal cells there are two or three layers of five- or six-angled sclerenchyma cells with thick, slightly lignified and silicified cell walls. In the longitudinal, or in macerated sections, these cells vary in length as well as in width. Haan(3) calls them hypodermal cells. The outermost layer of the sclerenchyma, or hypodermal, cells are in contact with the lower surface of the epidermal cells, and these outer cells exhibit very characteristic, minute outgrowths, or teeth, on one or two sides. These teeth are adjusted with the pits or corrugations of the epidermal cell walls. The sclerenchyma cells in the interior do not, however, have these teeth and are entirely smooth. The inner region of the lemma is occupied by two or three layers of tangentially elongated and slightly pitted parenchyma cells. These cells are bounded in the innermost part by a layer of remarkably large, thin-walled hyaline and empty, parenchyma cells called epithelium. In the mature grain these epithelial cells are completely pressed down and therefore inconspicuous or indistinguishable. Over the surface of these epithelial cells there are a few thin-walled, mostly two-celled hairs and some stomata. The stomata are composed of two bean-shaped guard cells surrounded by large subsidiary cells.

The vascular bundles of the lemma are very simple in structure and not well differentiated. The phloëm region consists of undifferentiated, small, thin-walled conducting cells, while the xylem region is composed of small, somewhat thick-walled vessels. A segment from the midrib of the lemma (Plate 2, fig. 21) shows the characters of the epidermal cells and the simple structure of the vascular bundle. This region usually is wider than the lateral portion of the lemma. The parenchyma region consists of six or seven layers of tangentially elongated parenchyma cells. On the same plate (fig. 17) can be seen a segment of a cross section from the lateral part of the lemma.

When the lemma was macerated with nitric acid and potassium chlorate the different tissue elements were separated from one another. The most conspicuous type of cells observed were the characteristic epidermal cells, the sclerenchyma and parenchyma cells, and the fragments of the hairs (Plate 5, fig. 43, *a–g*). The epidermal cells are deeply dentated and vary from 0.06 to 0.09 millimeter in length and from 0.05 to 0.12 millimeter

in width. The sclerenchyma cells are of two types; namely, the sclerenchyma cells with one or two rows of teeth or outgrowths and the plain sclerenchyma cells (without teeth). The sclerenchyma cells with teeth vary in length from 0.2 to 0.61 millimeter and those without teeth from 0.2 to 0.65 millimeter. The parenchyma cells are of two kinds. Some are elongated and have thick walls with a wavy outline and some are short and have thin walls. The hairs are usually found in fragmentary form of varying length.

The structure of the palea is very similar to that of the lemma, except that the region of the midrib is usually slightly thicker (measuring about 0.16 millimeter) and the middle vascular bundle is more differentiated than the corresponding vascular bundle of the lemma. The vascular bundle of the palea exhibits approximately the structure of a typical monocotyledonous vascular bundle. The bundle sheet and the two slightly large vessels are somewhat conspicuous, but the phloëm region is not differentiated distinctly into sieve tube and companion cells; moreover, the air space usually observed among the ordinary monocotyledonous vascular bundle is absent. A portion through the midrib of the palea is represented in Plate 2, fig. 13. A segment taken from the lateral part of the transverse section of the palea is shown on the same plate, fig. 18. The structure of the two lateral vascular bundles of the palea is very similar to the structure of the lateral vascular bundles of the lemma; that is, they are not well differentiated. The keels, as observed in a cross section, consist simply (in the outer and inner surface) of small, thick-walled, rectangular, epidermal cells. In the longitudinal section these cells are axially elongated. The inner region of the cross section of the keel is composed entirely of one or more layers of sclerenchyma cells with somewhat thin and silicified walls.

The tissue elements found in the macerated material of the palea exhibit the same characteristic and variation as those of the lemma (Plate 5, fig. 44, *a–h*). The only difference is that the epidermal cells are slightly smaller as a whole than those of the lemma, measuring from 0.03 to 0.08 millimeter in length and from 0.02 to 0.1 millimeter in width. The sclerenchyma cells with teeth, however, vary from 0.15 to 0.63 millimeter in length and those without teeth vary from 0.2 to 0.65 millimeter in length.

The two outer small glumes, in cross sections, are very similar. Their structures are simpler than those of the lemma and palea.

They consist of outer and inner epidermis and one or more layers of parenchyma cells in the middle region. The outer as well as the inner epidermis is built up of a single layer of nearly quadrangular, thick-walled, epidermal cells. In the surface view, these epidermal cells are elongated with thick and wavy cell walls, as illustrated on Plate 2, fig. 16. In the region of the midrib of the cross sections of the two glumes there is an incipient or poorly differentiated vascular bundle.

Plate 5, fig. 45, shows the different types of cells observed in the macerated material of the two outer empty glumes. The fibers may be pitted or unpitted and vary from 0.12 to 0.25 millimeter in length and from 0.01 to 0.02 millimeter in width. The parenchyma cells, like those of the lemma and palea, are also of two kinds; some are elongated, with thick walls and wavy outline, and some are short, with thin walls.

A thin cross section of a very young fruit is somewhat elliptic in outline. The ovary wall, or the young fruit wall, is about 0.07 millimeter thick with three vascular bundles—two at the lateral sides and one at the ventral side where the ovule is attached. The outer part of the ovary is limited by a single layer of tangentially elongated epidermal cells with very delicate thin walls. The inner part is bounded by a single layer of quadrangular or rectangular thin-walled cells. The space between the two epidermal regions is occupied by about ten layers of tangentially elongated, thin-walled, parenchyma cells, the two or three inner layers of which contain chloroplastids (Plate 2, figs. 21 and 22). The vascular bundles of the ovary are very simple and rudimentary in structure. The two lateral ones are not distinctly differentiated, but simply consist of small, polygonal cells with very thin walls. The third vascular bundle, located toward the lemma where the ovule is attached, is somewhat differentiated, being composed of very small, polygonal, thin-walled cells with dense protoplasm toward the outer part, and toward the inner part having small polygonal or rounded and empty cells with slightly thicker walls.

In the longitudinal sections, the outer epidermal cells are rectangular in outline and the parenchyma cells between the inner and outer epidermis vary from rectangular to quadrangular and in some cases are polygonal. The parenchyma cells decrease in size from the outer to the inner region. The inner epidermal cells, on the other hand, are greatly elongated—about twenty times as long as their diameter. For this reason these cells, which are observed even in the mature fruit, are called tubular

cells by Haan.(3) Plate 3, fig. 25, represents a segment drawn from a surface preparation of a young fruit wall, showing the distribution and characteristics of the greatly elongated epidermal cells.

The middle portion of the cross section of a very young fruit is occupied by the young endosperm, nucellus, and the inner integument. The outer integument is absorbed during the early stage of the developing embryo. Plate 2, fig. 19, represents a small segment of a cross section of a very young ovary taken through the integumental regions just before the cells of the outer integument are disorganized. On the same plate, fig. 20, is another segment of a thin transverse section also taken through the integumental region near the base of the fertilized and developing ovule. It shows a portion of the inner epidermis of the ovary wall, the basal portion of the disintegrating outer integument, the inner integument, and a portion of the nucellar region. Plate 3, fig. 23, shows a portion of a cross section, from the lateral side, through the corresponding regions shown in Plate 2, figs. 19 and 21. It illustrates the absorption of the inner nucellar cells. The inner integument at this stage consists of two layers of rectangular cells of unequal size. Those of the outer side are smaller and nearly quadrangular in outline, while the inner cells are larger, usually rectangular, and contain dense protoplasm.

Within the inner integument is found the nucellar region. It consists of large hyaline cells of varying shapes with extremely thin or delicate cell walls (Plate 2, fig. 21). The outer layer constitutes the epidermis of the nucellus, and it is composed of tangentially elongated or rectangular cells with dense protoplasm. In the longitudinal section they are either radially elongated, quadrangular, or somewhat axially elongated. The two or three (inner) remaining layers are either irregularly shaped, rounded, or tangentially elongated, with small intercellular spaces, and contain a small amount of protoplasm. In the longitudinal section they are usually axially elongated or rectangular in outline with slightly wavy cell walls (Plate 2, fig. 22). On the inner side the nucellar region is bounded by the young aleurone cells, which are tangentially elongated, have thin walls, and contain dense protoplasm. The nucellar cells, except those of the epidermis, become gradually pressed or disorganized and are absorbed by the developing embryo, as in the case of the wheat, except that the walls of the epidermal cells of the nucellus do not become thickened and lignified (Plate 3, figs. 23 and 24).

The structure of the endosperm in a cross section of a very young fruit shows that it is composed usually of polygonal or irregularly shaped parenchyma cells with extremely thin walls and contains a moderate amount of protoplasm. The outer part is limited by a layer of tangentially elongated thin-walled cells with denser protoplasm. This layer constitutes what is called an aleurone layer, for in the mature grain it contains a considerable amount of aleurone grains of proteins, and fatty oil (Plate 2, figs. 19 to 21). In the longitudinal section the endosperm cells also vary in outline. They are usually either polygonal or radially elongated as shown on Plate 2, fig. 22.

During the fertilization stage the ovule is rather small and somewhat separated from the ovary wall, but soon after fertilization the increase in size of the ovule is remarkable. The embryo sac is gradually filled up by the developing endosperm and embryo. While the size gradually increases the loose cells of the covering of the ovule are pressed together flatly. The only cells that remain unpressed are those that contain dense protoplasm, as, for instance, those of the epidermis of the nucellus and of the inner integument. At this stage the cells of outer integument begin to disorganize and finally disintegrate (Plate 2, figs. 19 and 20). As the young grain is ripening or maturing it continues to increase in size until the nucellar region and the cells of the inner integument are pressed flatly against the pericarp, and this in turn against the wall of the hull. Thus the filmy covering of the mature rice grain is composed of the pericarp, the inner integument or testa, and the nucellus or perisperm. These are all strongly pressed together into a very compact form in which the individual structure of the different tissue cells is lost. Because of this fact the filmy covering of the rice grain appears of one piece, as if derived from a single structure.

The color of the rice grain depends upon the color of the filmy covering, called by Haan(3) a silverfilm. The coloring matter is found in the inner layer of the testa.

The mature endosperm constitutes the kernel of the rice grain proper. In a thin cross section it appears more or less elliptical, the outer part being limited by the aleurone layer (Plate 3, fig. 29, and Plate 4, fig. 34). The aleurone layer is composed of a single layer of quadrangular or rectangular parenchyma cells with thin walls. These cells are filled up with small protein granules and some droplets of fatty oil (Plate 3, fig. 28). Within the aleurone layer at the dorsal side there are two short

layers of polygonal parenchyma cells, which also contain some protein granules and droplets of fatty oil (Plate 4, fig. 34). The endosperm is built up of thin-walled parenchyma cells, which are generally elongated radially, and heavily loaded with starch grains and some protein granules. Those that are found toward the flattened or lateral sides are either polygonal or slightly elongated, but those that are extended from the ventral to the dorsal side are greatly elongated. The endosperm cells in the sector toward the ventral region, which corresponds to the part occupied by the abdominal white, contain practically only starch grains. A critical microchemical test shows that the protein contents of the endosperm cells mixed with the starch grains decrease proportionally from the periphery toward the region of the abdominal white. The starch grains are elliptical, oval, or nearly spherical, and measure from 0.015 to 0.055 millimeter in length and from 0.012 to 0.035 millimeter in width (Plate 5, fig. 46). They are composed of many-cornered (polyedric) grainlets, measuring from 0.003 to 0.008 millimeter. The sides of these grainlets fit in with, or are adjusted to, each other, but those at the outer part, or periphery, are convex.

The rice embryo is relatively small. It is only about one-third the length of the fruit and it is located near the base, toward the lemma or ventral side of the grain.

In the longitudinal section of the grain, cut parallel to the flat side, the embryo appears more or less lenticular in outline. In the middle part the plumule and primary root are arranged in the form of a capital L; that is, the plumule corresponds to the longer vertical arm, while the primary root corresponds to the short horizontal arm. These are joined to each other by a short stem, more or less at right angles, and embedded or surrounded by a mass of thin-walled polygonal parenchyma cells, which form the scutellum, epiblast, and coleorhiza as represented on Plate 3, fig. 26. The ventral side of the embryo is protected by the prolongation of the aleurone region from the upper part of the embryo to the base and serves as an epidermis. This epidermis in turn is covered by the pericarp, which is pressed together with the seed coats. The same plate (fig. 27) represents another diagrammatic, median, lengthwise section showing the structure of the embryo. In this diagram the primary root is almost rounded in outline and surrounded by a mass of soft tissue, known as root sheath or coleorhiza.

The plumule, or the primary bud, is somewhat ovate in outline, pointing obliquely away from the apex of the grain. It is

composed of a minute growing point, one or more foliage leaves, and a coleoptile. The growing point is the region surrounded by one or more immature foliage leaves, which are attached to the upper end of the hypocotyl. The leaf sheath, or coleoptile is the structure that incloses the growing point and the foliage leaves. The plumule is bounded at the inner side by a specialized structure, the scutellum or cotyledon, which lies next to the endosperm and is attached to the hypocotyl. At the region where the root sheath merges into the hypocotyledonary tissue there is a projecting structure, which extends toward the upper end of the tip of the plumule and overlaps with the upper end of the scutellum. This projecting structure, devoid of vascular tissue, is known as epiblast. In the case of wheat, the epiblast is greatly reduced in size and, according to Robbin,(7) it has been suggested that the scutellum and epiblast represent two cotyledons; one, the scutellum, is highly modified, while the other, the epiblast, is suppressed. Between the plumule and the primary root there is a very short stem, called hypocotyl, which terminates at the anterior end in a stem-growing point, and at the posterior end extends into the primary root.

A critical microscopical examination of the embryo shows that, in a longitudinal section, the plumule and the primary root are composed of thin-walled parenchyma cells with square, polygonal, or elongated outline (Plate 4, figs. 40 and 41). These are surrounded by epithelial cells, which are also somewhat radially elongated. The parenchyma cells of the plumule and the primary root, together with the corresponding epithelial cells, are filled with minute protein granules and small droplets of fatty oil. The outermost layer of the scutellum, toward the endosperm, consists of radially elongated thin-walled parenchyma cells, which are arranged somewhat in a palisade form (Plate 3, fig. 30, and Plate 4, fig. 42). This layer is known as epithelium. The epithelial cells are filled with minute protein granules and small droplets of fatty oil. They extend to the base, to the stem, and to the coleorhiza.

The inner cells of the cotyledon, in cross or longitudinal sections, appear to be polygonal and of varying size. They have very thin walls and are filled with minute protein granules and small droplets of fatty oil. The cotyledonal cells toward the seed coat are somewhat larger than the inner cells and those of the outermost layer are tangentially elongated (Plate 3, fig. 31). During germination the scutellum remains with the endosperm and serves as an absorbing and conducting organ for the mate-

rial from the endosperm to the growing regions. The epiblast, like the scutellum, is composed of thin-walled, rectangular or polygonal parenchyma cells containing proteins and fatty oil. It is surrounded by an epithelium. Plate 3, fig. 30, represents a segment of a thin section (highly magnified) through the outer region between the scutellum and endosperm. It shows their relative positions, their cellular contents, and the extension of the aleurone region to the outer surface of the embryo. On the same plate is another segment (fig. 32) from a thin section in the outer and lower region of the apical part of the scutellum. This segment indicates the relation between this part of the scutellum and the portion of the upper part of the epiblast and shows how they are held together by the extension of the aleurone layer. On the same plate fig. 33 represents another segment from the basal part of the grain. It shows the relation between the endosperm and the coleorhiza as covered by the extension of the aleurone layer.

Structure of the polished rice grain.—The polished rice grains (kernels) are slightly smaller in size than the unpolished ones and generally some are cut either into two equal or unequal parts. Their outer surface is smooth, nonglistening, waxy white, and with or without prominent chalklike abdominal white. The two parallel ridges on each of the flat surfaces are inconspicuous. The embryo is usually removed or knocked off during the polishing of the grains, as illustrated on Plate 1, fig. 11. A thin transverse section of the polished rice kernel shows that in the process of polishing not only the pericarp, seed coats, and embryo are removed but also most of the aleurone layer, which is the region of the rice grain containing proteins and fatty oil. Plate 4, figs. 35 and 36, are reproduced from thin transverse sections of polished rice grains of the macan and elon-elon varieties. On the same plate, figs. 37 and 38, are two highly magnified segments from a transverse section of the elon-elon variety. As shown by the drawing in fig. 37, not only the aleurone layer is removed, but also a portion of the outer layer of the endosperm cells. Figure 38 shows a segment taken from the groove region, where a small portion of the aleurone layer is left. Plate 4, fig. 39, represents a segment from macan variety corresponding to that of fig. 38, in which a very small portion of the aleurone layer remains after the polishing. It is quite evident, therefore, that in polished rice, the embryo and most of the aleurone layer are removed. The polished rice is, therefore, much less nutritious than the unpolished.

Rice bran.—The portion of the grain removed during the polishing of rice is called rice bran. . It is also known as darak, tikitiki, or rice polishings. The bran consists of fragments derived from the pericarp and seed coats together with a greater portion of the aleurone layer, part of the endosperm, and the embryo. Sometimes the bran contains particles of rice hulls that got into the bran accidentally or have been purposely added. The shape and size of the fragments and even the components of the rice bran vary according to the rice mill in which the rice bran is produced. The quality of the rice bran depends upon the amount of the fragments derived from the hull and from the two small outer glumes. However, when the rice bran is carefully prepared, especially by the modern type of rice mill, it is almost entirely free of hull fragments. An examination of a sample of rice bran obtained from a rice mill in Rizal Province showed that it consists entirely of the fragments of the pericarp adhering to the seed coat with the aleurone layer, endosperm cells with starch grains, the embryo, and some small fragments of hairs (Plate 6, figs. 47 to 53). A microchemical test of rice bran shows it to be very rich in protein, fat or fatty oil, starch, and soluble carbohydrates contained in fragments of the embryo. As the fragments from the pericarp and testa are compressed into a compact form, the cells are empty and apparently without nutritive substances. It is quite evident, therefore, that the vitamins found in the bran (tikitiki) extract are derived from the embryo and the aleurone region of the rice grain. Plate 7, figs. 54 to 61, represent the fragments of rice bran improperly prepared and containing some rice hulls.

Microchemical tests.—The microchemical investigation on the mature rice grain and the rice polishings (rice bran) was limited to the determination and localization of the substances that have direct bearing on its nutritive value as human food. That is, the starch, protein, fat or fatty oil, and other carbohydrates. A thin cross section of the kernel was treated with a dilute solution of iodopotassium iodide. The contents of all the endosperm cells were thus stained blue, except those of the aleurone layer. This indicates that the greater part of the contents of the endosperm cells consists of starch grains. A closer examination of the treated section also shows that between the starch grains and especially near the sides of the cell walls there are very minute granules stained yellow, or brownish yellow, by the iodine. These yellow-colored granules are protein substances. Large quantities of similar granules fill the greater part of the

cavity of the aleurone cells. When another section was treated with a saturated solution of picric acid, the granules (previously stained brownish yellow by the solution of iodopotassium iodide) became yellow, while the starch grains remained colorless. This proves conclusively that the protein substance is contained largely in the aleurone cells and in comparatively smaller amounts in the endosperm cells. On the other hand when another cross section of the endosperm was treated with freshly prepared tincture of alkana only the fat or oil globules in the aleurone cells were stained a pink or reddish color. The oil globules were colored brown also when treated with 1 per cent osmic acid. In some other sections Fehling's solution was applied, but no positive results were obtained. Transverse and oblique sections through the embryo were also treated in the same manner. It was found that the cells of the aleurone region, the scutellum, the plumule, and the radicle contain a considerable amount of protein substances and oil globules. Moreover, when some sections from the embryo were treated with Fehling's solution, a reddish brown precipitate was observed. This shows that the embryo is not only rich in protein and oil, but also contains some soluble carbohydrates. Since the rice bran generally is derived from the aleurone region, endosperm, pericarp, seed coats, and embryo, it is to be expected that the bran will have the substances contained in these sections. When small portions of rice bran were treated with the above reagents, which were used in the sections, it was found that the fragments derived from the embryo consist mostly of proteins, fatty oil, and soluble carbohydrates. Those from the aleurone layer contain these same substances except the soluble carbohydrates. The fragments derived from the endosperm showed positive reactions for starch and proteins. The pericarp, seed coat, and fragments of the hull did not react to the different reagents, except when they were contaminated with the substance of the fragments derived from the aleurone region, endosperm, and embryo.

Microchemical tests were also made on the section of the lemma and palea, but no positive results were obtained.

DISCUSSION OF RESULTS

With definite varieties of rice the flower parts of a rice spikelet are usually constant. The individual flower parts in different rice varieties show much diversity in various features; namely, size, shape, color, tips, surface outgrowth or hairs, etc. The great variations among the grains of the different rice varieties

are due to the modifications of the flower parts, some of them simply acquired, but most of them hereditary. Some of these characters have consequently been used by several authors in the attempt to classify rices. During the last two decades they have been, and still are, important subjects for genetic investigation by rice breeders.

The outer glumes generally are small, smooth and shiny, but in one well-known variety in the Philippines (pirurutong) they are large, almost equalling or, in some cases, exceeding the lemma and palea in length. The young lemma and palea, which represent the inner glumes, are usually light green and with or without a dark purple spot at the apex; upon ripening they become yellowish white or straw-colored. In some cases, however, they may be orange, red, brown, purple, or nearly black with many different shades. The apex of the flowering glume or lemma is ordinarily obtuse or acute, although in some cases it is provided with a hard bristlelike prolongation of varying length and color and known as "awn." Kikkawa(6) claims that most of the prevalent varieties in advanced centers of rice culture are awnless. Sethi and Saxena,(9) on the other hand, observed that awns are generally found in coarse types, and that wild uncultivated types and usually those grown in some swamps also show abundant production of awns. This observation seems to agree with some of the Philippine rice varieties; such as, *lampadan, pirurutong, igorot, pasayan, mambog II, mantica, uuac, paringayod, maralesa, dekita lacay, gracia, madre de casa, marapa, sinamporin,* and many others.

The size and the shape of the rice grain (caryopsis) differ with the variety, and therefore are important from the standpoint of taxonomy. They are useful as diagnostic characters and have been used by almost every rice taxonomist in the classification of the varieties of rices. The Philippine rice varieties exhibit a great diversity in size and shape (Plate 1, figs. 1 to 10). Some varieties have small and slender grains, others have short and broad grains, and still others have long and broad ones. Sethi and Saxena(9) distinguished three groups of grains of the rice varieties found in the United Province of India; namely, slender, long, and short. When the length of the grains is three times as great as the breadth, or more, it is called "slender;" when the length is more than twice but less than three times the breadth it is known as "long;" and when the length equals twice or less than twice the breadth it is called

"short." Graham,(1) working with rices in the Central Provinces of India, divides the sizes of the spikelets into four groups, as follows:

1. *long* spikelets in which the length is more than four times the breadth,
2. *fine*, in which the length is more than three times the breadth,
3. *coarse*, in which the length is more than twice the breadth, and
4. *round*, in which the length is less than twice the breadth.

The rice kernel is generally whitish or very light cream in color, but in some cases it is red, like some of the grains of Macan I, and it may be violet-black or purplish black as in the grains of "pirurutong." In the white varieties, the abdominal white may be conspicuous or inconspicuous. This abdominal white according to Inagaki, as quoted by Kikkawa,(6) is nothing but a portion of the rice grain where spaces between the starch grains are not filled with albuminous substances. Tanaka(13) agrees with the findings of Inagaki, but he believes that the formation of the abdominal white is due to an insufficient supply of nutritive matter during the ripening time, to abnormal arrangements, or to an improper proportion of the accumulated substances in the grain. The chemical analysis made by U. Suzuki and K. Aso,(12) showed that the chalky region of the rice grain has an abnormally low percentage of albuminoids. On the other hand Kikkawa(6) states it can be said safely that the abdominal white fluctuates according to climate, weather, and method of cultivation, but its heredity is not yet determined. He believes that a similar difference of texture also exists in the glutinous rice, but because the endosperm of the glutinous rice is generally uniformly chalk-colored, they cannot be distinguished. The findings of the writer quite agree with those of Inagaki and Kikkawa.(6)

The above results of the microscopical examination of the lemma and palea confirm Weatherwax's(16) claim of five vascular bundles in the lemma and three vascular bundles in the palea. These vascular bundles are not indicated in the detailed study made by Haan.(3) The structure of the covering of the rice grain is very similar to that of wheat; that is, it consists of pericarp derived from the ovary wall, testa developed from the inner integument, and perisperm from the nucellus; the outer integument is absorbed during the development of the embryo. The only difference is that the perisperm is not made up of cells with strongly thickened walls and with indistinct cavities. Moreover, the filmy covering of the rice grain is comparatively thinner than that of the wheat, and the inner epi-

dermal cells of the pericarp are developed into tubular cells. However, the results obtained on the development of the filmy covering agree perfectly with those of Haan(3) who called it "zilvervlies" (silver film). The color of the rice grain is due to the coloring matter deposited in the inner layer of the testa.

The endosperm is limited in the outer part by an aleurone layer filled with fat, or oil, and protein granules. It consists of thin-walled, radially elongated, parenchyma cells richly supplied with starch grains and contains a relatively large amount of protein substances.

The small embryo is somewhat similar in structure to that of wheat. It consists of a primary root, leaf sheath or coleoptile, plumule, scutellum, coleorhiza, and epiblast. It contains a considerable quantity of protein substances, fat or oil, and soluble carbohydrates, but no starch.

The bran of rice, like wheat bran, which is extensively used in bread making, includes the three outer layers of tissues; namely, pericarp, testa, and nucellus or perisperm, and also the embryo. The pericarp constitutes the largest proportion of the bran. The protein contents, fat or oil, and soluble carbohydrates of the bran, are derived from the aleurone cells and the embryo, while the starch content is derived from the endosperm cells, which adhere to the bran layers in the milling process.

Commercial rice bran consists of the fine, scalelike, flaky, outside covering of the rice kernel removed during the polishing. This is composed of the pericarp, testa, perisperm, most of the aleurone layer, some starchy endosperm, and usually the whole or fragments of the embryo. Fragments of the hull and the two outer small empty glumes, remnants of the stigma, and also portions of the lodicules may sometimes be found in the bran due to improper milling. The latter fragments are either accidentally or purposely mixed with the former fragments. Microchemical tests showed that they do not contain oil or fat, protein substances, starch, or soluble carbohydrates.

SUMMARY AND CONCLUSIONS

1. The essential parts of a rice flower, technically known as spikelet, are the following: (*a*) Two small bristlelike outer glumes; (*b*) a boat-shaped flowering glume, or lemma; (*c*) a palea, a glume similar in size, shape, and texture to the lemma; (*d*) two small, oval, thick, and fleshy structures known as lodicules; (*e*) six stamens; and (*f*) a pistil with a plumose stigma.

2. The lemma and palea are five- and three-nerved, respectively.

3. The structure of lemma and palea in transverse sections is more or less similar. Their composition is as follows: (*a*) Remarkably large epidermal cells with corrugated, thick, lignified, pitted walls and silicified or lined with silica in the outer part; in the surface view they are dentated or dentately parted; (*b*) few simple hairs between the epidermal cells; (*c*) two or three layers of sclerenchyma cells, the outer layers of which are characterized by minute outgrowths or teeth; (*d*) two or three layers of tangentially elongated and colorless parenchyma cells; (*e*) a layer of large, thin-walled, hyaline and empty parenchyma cells known as epithelium.

4. The vascular bundles of the two glumes are quite similar in structure, consisting of small undifferentiated phloëm cells and poorly developed xylem vessels.

5. Few stomata and simple hairs are found in the inner surface of the lemma and palea.

6. The young grain coat consists of (*a*) outer epidermis; (*b*) seven to nine layers of tangentially elongated, colorless, parenchyma cells; (*c*) two or three layers of rectangular chlorenchyma cells; (*d*) inner epidermis composed of a single row of small cells; (*e*) outer integument, two layers of cells; (*f*) inner integument, also two layers of cells; (*g*) nucellus built up of several layers of thin-walled parenchyma cells.

7. The mature grain coat consists of a filmlike covering composed of the following structures: The ovary wall or pericarp, the inner integument and nucellus which are pressed together flatly in a somewhat compact form.

8. The kernel is oblong oval, usually smooth and glistening, whitish or translucent waxy white, with or without abdominal white. Sometimes it is red or purplish black.

9. The endosperm is built up of thin-walled, elongated, parenchyma cells filled with starch grains and some protein substances. The outer part of the endosperm is limited by a layer of rectangular cells known as aleurone cells, which are rich in proteins and fat or oil globules.

10. The embryo is small and rich in protein, fat or oil, and soluble carbohydrates.

11. Microchemical tests showed that the aleurone cells are filled with a large amount of fat or oil and protein; the endosperm cells contain starch grains and a relatively large amount of proteins; the embryo is very rich in fat or oil and proteins,

and contains soluble carbohydrates. The pericarp, seed coat, and the hull possess no fat or oil, starch, protein, or soluble carbohydrates.

12. The rice bran consists of the fragments derived from the outer covering of the kernel. It is composed of the pericarp, testa, and the perisperm with the portion of the aleurone layer adhering to it. In addition, fragments or the entire embryo and particles of the endosperm are usually included in it, and in some cases fragments from the hull that are either accidentally or purposely mixed with the above.

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ILLUSTRATIONS

[Most of the microscopic drawings were prepared under camera lucida by the author. Some were traced by Mr. J. V. Santos and Miss Trinidad Villegas, of the Department of Botany, University of the Philippines. The habit sketches of the flower and fruit were drawn by Mr. M. Ligaya, and the photograph was prepared by the Bureau of Science.]

PLATE 1. ORYZA SATIVA LINNÆUS

FIG. 1. Hulled and unhulled rice variety *apostol;* × 3.2.
2. Hulled and unhulled rice variety *elon-elon;* × 3.2.
3. Hulled and unhulled rice variety *macan* I; × 3.2.
4. Hulled and unhulled rice variety *macan biñan;* × 3.2.
5. Hulled and unhulled, *a* and *b*, rice variety *lampadan;* × 3.2.
6. Hulled and unhulled rice variety *macan santa rosa.*
7. Hulled and unhulled rice variety *malagkit* (striped); × 3.2.
8. Hulled and unhulled rice variety *quinastila;* × 3.2.
9. Hulled and unhulled rice variety *ramay;* × 3.2.
10. Hulled and unhulled, *a* and *b*, rice variety *pirurutong;* × 3.2.
11. Polished and unpolished kernel of the rice variety *elon-elon;* × 3.2.

PLATE 2. ORYZA SATIVA LINNÆUS VAR. KINAMPUPOY

FIG. 12. A segment from the middle portion of a thin transverse section of the lemma; *e*, epidermis; *scl*, sclerenchyma; *si*, siliceous covering; *p*, parenchyma; *vb*, vascular bundle; and *ie*, inner epithelium; × 416.
13. A segment from the middle portion of a thin transverse section of the palea; *e*, epidermis; *scl*, sclerenchyma; *si*, siliceous covering; *p*, parenchyma; *vb*, vascular bundle; *v*, vessel; × 416.
14. A portion of a surface section of the epidermis, showing the remarkably deeply dentated epidermal cells, their arrangement and their interlacing between each other; *h*, hair; × 416.
15. A reconstructed diagrammatic drawing of an epidermal cell, highly magnified.
16. A portion of a surface preparation of the lower epidermis of the first outer empty glume showing the axially elongated epidermal cells with wavy, thick, and pitted walls; × 416.
17. A small segment from the lateral part of a thin transverse section of the lemma; *e*, epidermis, *scl*, sclerenchyma; *p*, parenchyma; *si*, siliceous covering; *ie*, inner epithelium; × 232.
18. A small segment from the lateral part of a thin transverse section of the palea; *e*, epidermis; *scl*, sclerenchyma; *p*, parenchyma; *si*, siliceous covering; *ie*, inner epithelium; × 232.
19. A small portion from a thin transverse section through the integumental region of a young ovary; *pe*, pericarp; *tc*, inner epidermis; *ii*, inner integument; *n*, nucellus; × 416.

FIG. 20. Another small segment from a thin transverse section through the integumental region of a young ovary; *pe*, pericarp; *oi*, disorganizing outer integument; *ii*, inner integument; *n*, nucellus; × 416.

21. A portion of a transverse section of the ovary during the development of the embryo showing, *pe*, pericarp; *vb*, vascular bundle; *tc*, tubular cells; *ii*, inner integument; *n*, nucellus; *al*, young aleurone cells; *en*, young endosperm cells; × 416.

22. A portion of a thin longitudinal section of the ovary during the development of the embryo; *pe*, pericarp; *tc*, tubular cells; *ii*, inner integument; *n*, nucellus; *al*, young aleurone cells; *en*, young endosperm cells; × 416.

PLATE 3. ORYZA SATIVA LINNÆUS VAR. KINAMPUPOY

FIG. 23. A small segment from a thin transverse section through the nucellar region of the ovary during the development of the embryo showing, *pe*, pericarp; *tc*, tubular cells; *ii*, inner integument; *n*, nucellus, the inner layers of which are disorganized and absorbed by the young embryo; *al*, young aleurone cells; × 416.

24. A portion from a thin longitudinal section through the nucellar region of the ovary during the development of the embryo, showing the gradual disintegration and absorption of the inner nucellar cells; *al*, young aleurone cells; *en*, young endosperm cells; × 416.

25. A portion from a surface preparation of the tubular cells; *tc*, tubular cells; *ii*, inner integument cells; *pc*, parenchyma cells from the innermost layer of the pericarp; × 416.

26. A diagrammatic sketch of a longitudinal section cut parallel to the flat surface of a rice kernel variety *malagkit*, showing, *l*, lemma; *p*, palea; gl_1, first outer empty glume; gl_2, second outer empty glume; *h*, hair; *ps*, filmy covering of the kernel consisting of pericarp and seed coats; *en*, endosperm; *al*, aleurone layer; *e*, epithelium of the scutellum; *s*, scutellum; *pl*, plumule; *r*, primary root; *ep*, epiblast; × 6.2.

27. A diagrammatic longitudinal section of the embryo cut parallel to the flat surface of the kernel; *al*, aleurone layer extended to the ventral side of the embryo; *s*, scutellum; *ep*, epiblast; *col*, coleoptile; *fl*, first foliage leaves; *gp*, growing point; *hy*, hypocotyl; *cc*, crushed cells; *en*, endosperm; *co*, coleorhiza; *ps*, pericarp and seed coats pressed together; × 28.7.

28. A segment from a thin transverse section through the aleurone region and covering of the kernel; *ps*, filmy covering of the kernel consisting of the pericarp and seed coats compressed together; *al*, aleurone layer; *og*, fatty oil globules; *pg*, protein granules; *en*, endosperm; *sg*, starch grain; × 416.

29. A diagrammatic drawing of a transverse section of a mature rice grain of *malagkit* variety; *l*, lemma; *p*, palea; *vb*, vascular bundles; *k*, keel; *ps*, filmy covering of the kernel consisting of the pericarp and seed coats pressed together; *al*, aleurone layer; *en*, endosperm; × 23.

FIG. 30. A segment from a thin longitudinal section through the region between the upper part of the scutellum, *en*, endosperm and aleurone layer; *ps*, pericarp and seed coats pressed together; *en*, endosperm; *al*, aleurone layer; *s*, scutellum; *e*, epithelium; *cc*, crushed cells; *sg*, starch grain; × 416.

31. A small segment from the outer part of a thin longitudinal section of the scutellum showing, *og*, fatty oil globules; *pg*, protein granules; × 416.

32. A portion from a thin longitudinal section through the region between the lower part of the tip of the scutellum, the upper side of the epiblast and the extension of the aleurone layer; *og*, fatty oil globules; *pg*, protein granules; × 416.

33. A segment from a thin longitudinal section through the base of the embryo; *sg*, starch grains; *en*, endosperm; *pg*, protein granules; *al*, aleurone layer; *og*, fatty oil globules; *ep*, epithelium; *co*, coleorhiza; *sc*, seed coats; *pe*, pericarp; × 416.

PLATE 4. ORYZA SATIVA LINNÆUS VAR. ELON-ELON AND MACAN

FIG. 34. A transverse section of the kernel showing the structure of the endosperm; *ps*, pericarp and seed coats pressed together; *al*, aleurone layer; *aw*, region of the abdominal white; *en*, endosperm; × 26.4.

35. A transverse section of a polished macan rice kernel; *al*, a small portion of the aleurone layer; *aw*, region of the abdominal white; × 26.4.

36. A transverse section of a polished elon-elon rice kernel; *ps*, pericarp and seed coats pressed together; *al*, portion of the aleurone layer spared from the polishing; *aw*, region of the abdominal white; × 26.4.

37. A small segment from a thin transverse section of polished elon-elon rice kernel showing that portions of the endosperm cells are also removed; *sg*, starch grains; *pg*, protein granules; × 64.

38. Another small segment from the groove region of a transverse section of a polished elon-elon rice kernel; *og*, fatty oil globules; *pg*, protein granules; *sg*, starch grains; × 64.

39. A segment from the groove region of a section of a polished macan rice kernel; *og*, fatty globules of the remaining portion of the aleurone layer; *sg*, starch grains; × 64.

40. A small segment from the lateral side of a longitudinal section of the plumule; *e*, epithelium; *pg*, protein granules; *og*, fatty oil globules; × 410.

41. A small segment from the lateral part of a longitudinal section of the primary root; *e*, epithelium; *og*, fatty oil globules; *pg*, protein granules; × 410.

42. A segment from a longitudinal section through the region between endosperm and scutellum; *og*, fatty oil globules; *pg*, protein granules; *e*, epithelium of the scutellum; *cc*, crushed cells; *sg*, starch grains; × 410.

PLATE 5. ORYZA SATIVA LINNÆUS VAR. KINAMPUPOY

FIG. 43. A group of isolated cells from a maceration of the lemma; *a*, epidermal cells; *b*, sclerenchyma cells with dentation or outgrowths; *c*, sclerenchyma cells; *d*, fragments of hairs; *e*, fibers and parenchyma cells with thick walls; *g*, basal part of the hair; × 150.

44. A group of isolated cells from a maceration of the palea; *a*, epidermal cells; *b*, epidermal cells from the region near the keel; *c*, sclerenchyma cells with dentation or outgrowths; *d*, sclerenchyma cells; *e*, fragments of hairs; *f*, parenchyma cells with thin walls; *g*, portion of the epidermis with two sclerenchyma cells with dentations in the inner part; *h*, parenchyma cells with thick walls; × 150.

45. A group of isolated cells from the maceration of the outer empty glumes; *a*, elongated cells or fibers derived from the region of the midrib or vascular part; *b*, parenchyma cells, some of which are derived from the epidermis; × 150.

46. A group of starch grains and grainlets; × 630.

PLATE 6. ORYZA SATIVA LINNÆUS

FIG. 47. Fragments from the filmy covering of the rice kernel showing the tubular cells *tc*; × 114.

48. Two fragments of the filmy covering of the rice kernel highly magnified; × 467.

49. Some fragments from the embryo; *pl*, plume; × 114.

50. Two fragments from the aleurone region of the rice kernel; *pg*, protein granules; *og*, fatty oil globules; × 114.

51. A group of endosperm cells containing starch grains and protein granules; × 114.

52. Some hair fragments adhering to the rice bran; × 114.

53. A highly magnified endosperm cell; × 467.

PLATE 7. ORYZA SATIVA LINNÆUS

FIG. 54. a–k Fragments of the rice hull mixed with the rice bran; × 60.

55. Fragments derived from the rice embryo; *a*, fragment from the primary root; *b*, and *c*, fragments from either the scutellum, epiblast or coleorhiza; *d*, terminal part of the plumule; *e*, the essential part of the embryo with the surrounding tissue removed; × 60.

56. Fragments from the outer empty glumes; × 60.

57. Fragments of hairs; × 60.

58. Some fragments from the filmy covering of the rice kernel showing the characteristics tubular cells; × 60.

59. Endosperm cells containing starch grains and protein granules, and isolated starch grains and grainlets; × 60.

60. Fragments from the stigma; × 60.

61. Fragments from the aleurone layer with the adhering filmy covering; × 60.

TEXT FIGURES

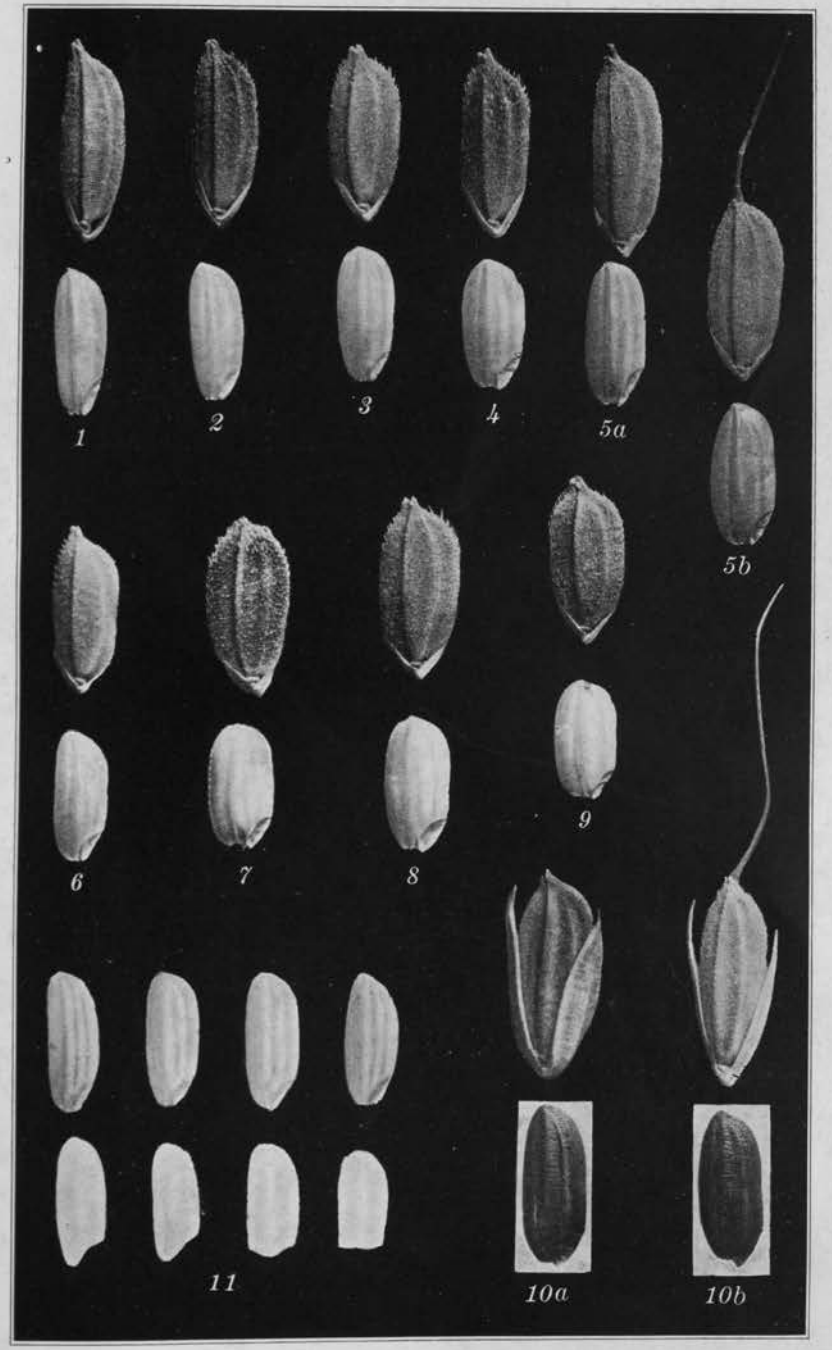
FIG. 1. An open flower of the rice variety kinampupoy; gl_1, first outer empty glume; gl_2, second outer empty glume; *l*, lemma; *p*, palea; *s*, stigma; *st*, stamen; × 10.

2. A diagrammatic drawing of a cross section of a rice flower with a portion of the lemma removed to show the relative position of its essential parts.

3. A rice floral diagram; gl_1, first outer empty glume; gl_2, second outer empty glume; *l*, lemma; *p*, palea; *k*, keel; *lo*, lodicule; *h*, hair; *o*, ovary; *st*, stamen; *vb*, vascular bundle. Reference letters are the same for figs. 3 and 4.

4. A habit drawing of a kinampupoy rice grain; gl_1, first outer empty glume; gl_2, second outer empty glume; *l*, lemma; *p*, palea; *h*, hair; × 10.

5. A habit drawing of a kinampupoy rice kernel; *en*, endosperm; *em*, embryo; × 10.



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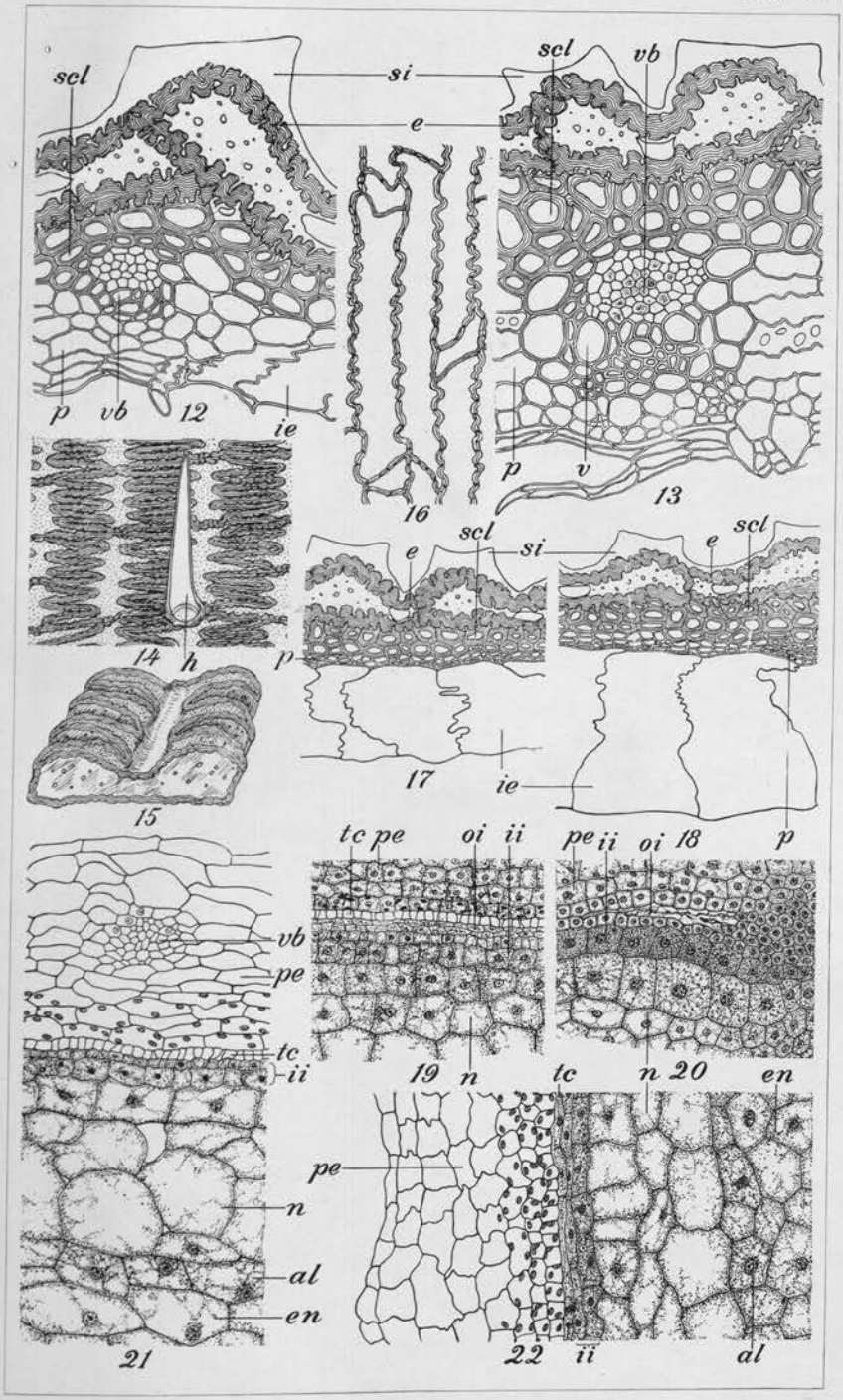
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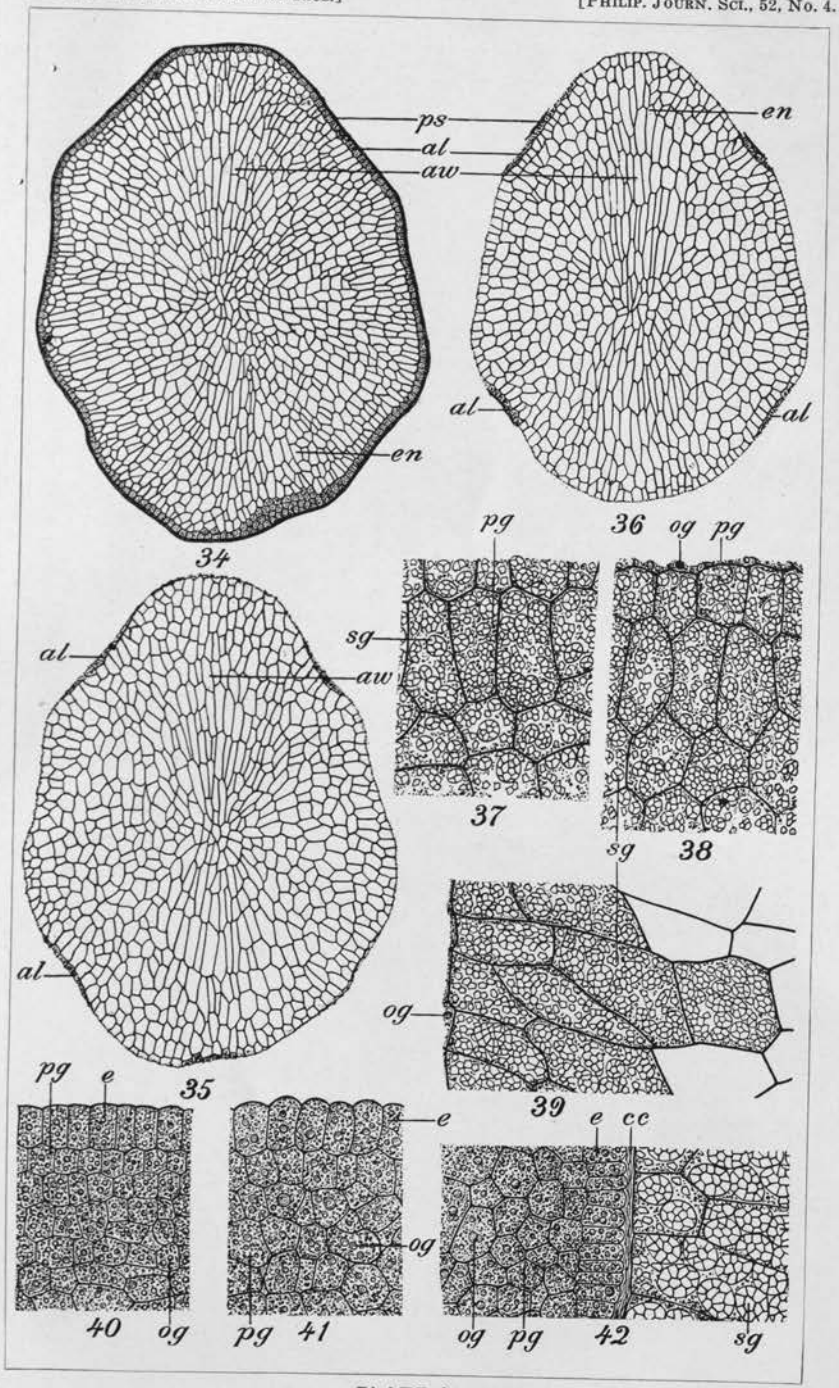
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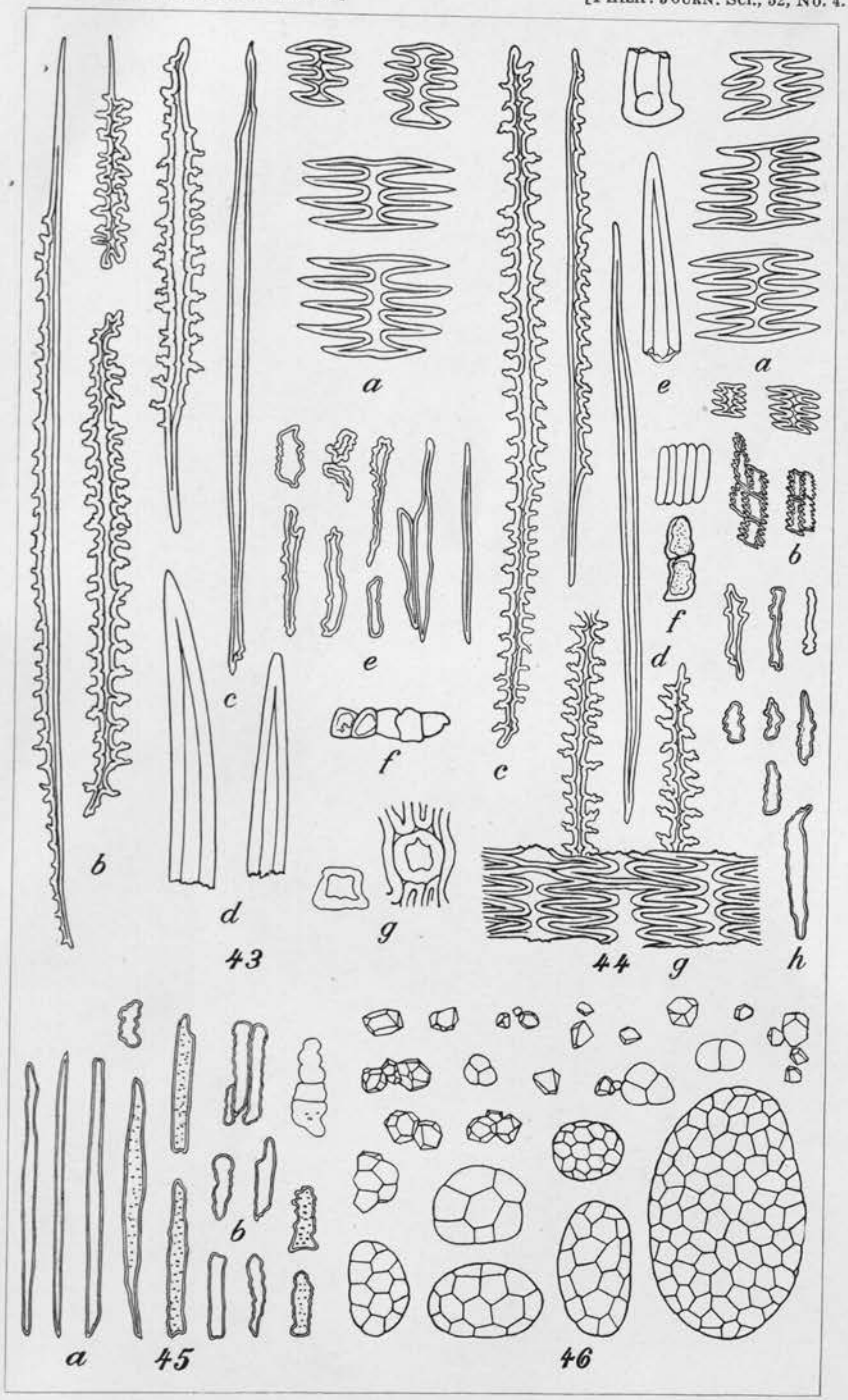

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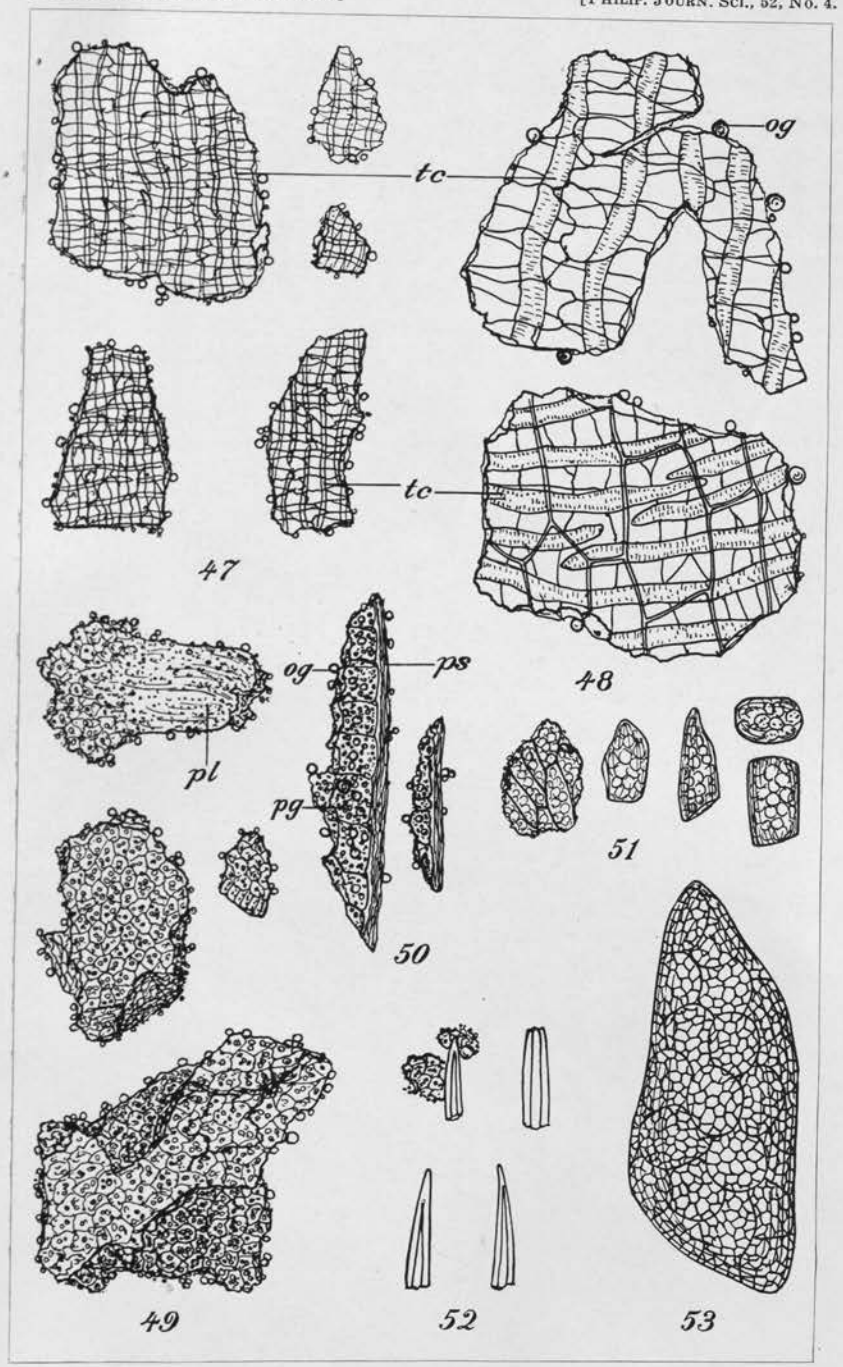

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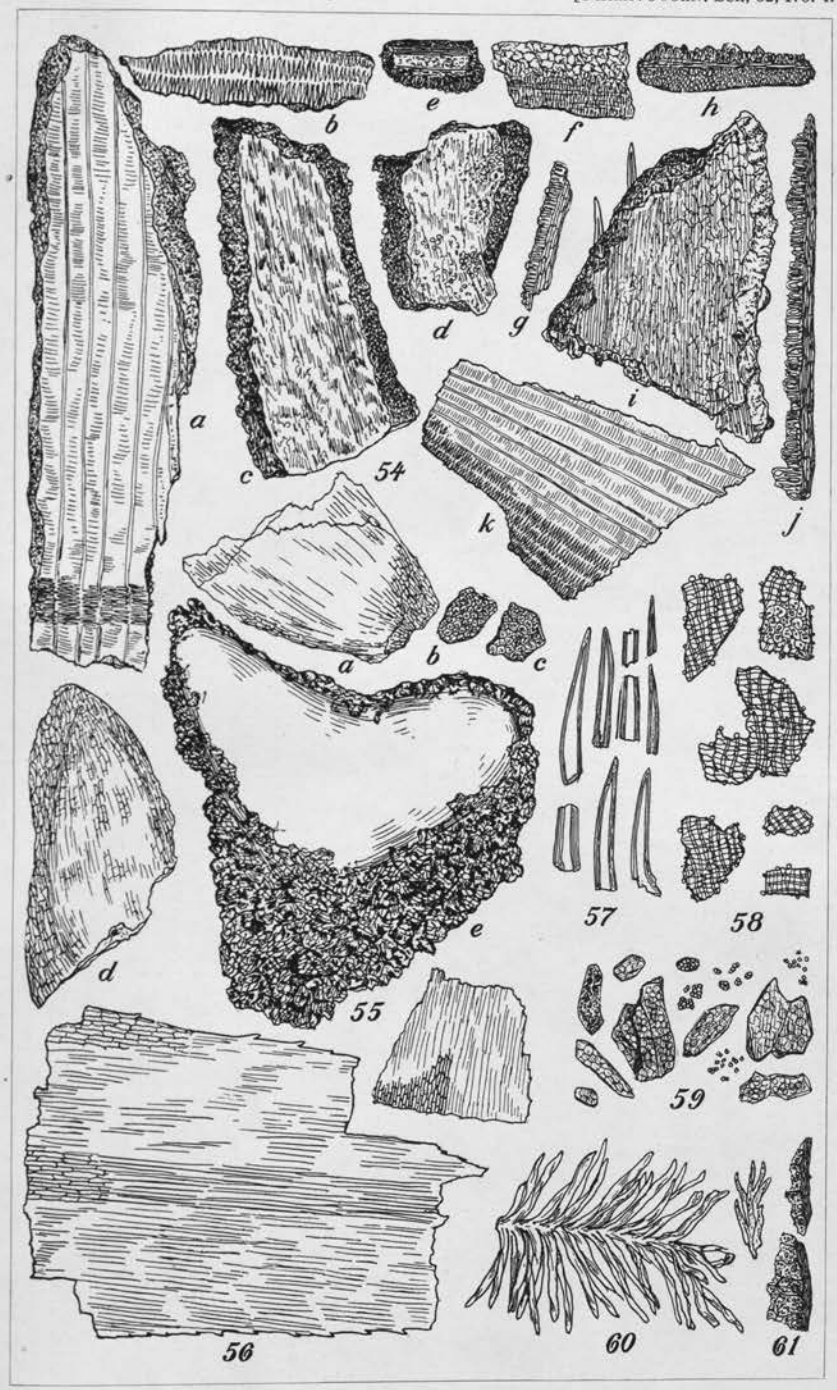

PLATE 7.

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